UNITED STATED DEPARTMENT OF AGRICULTURE

FOREST SERVICE

REGION 1
MISSOULA, MONTANA

# FSH 2209.22 R-1

# STRUCTURAL RANGE IMPROVEMENT HANDBOOK

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FOREST SERVICE HANDBOOK
MISSOULA, MONTANA

November 1984

FSH 2209.22 R-1 - STRUCTURAL RANGE IMPROVEMENT HANDBOOK

Region 1 Amendment No. 1

POSTING NOTICE. Amendments to this title are numbered consecutively. Check the last transmittal received for this title to see that the above amendment number is in sequence. If not, order intervening amendments at once on form 1100-6. Do not post this amendment until the missing one(s) is received and posted. After posting retain this transmittal until the next amendment to this title is received. Place it at the front of the title.

| Page Code | Superseded (No. of Sheets) | New |
|---|---|---|
| 100 through 120.1--10 | 7 | - |
| 100 through 110 | - | 2 |

12/4/84 JB

Digest:

Information in Section 120 is now in FSH 2209.11 - Range Project Effectiveness Analysis Procedures Handbook.

TOM COSTON
Regional Forester

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE, REGION 1

# STRUCTURAL RANGE IMPROVEMENT HANDBOOK

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# STRUCTURAL RANGE IMPROVEMENT HANDBOOK

## CHAPTER 100 - INTRODUCTION

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GENERAL

United States Department of Agriculture | Forest Service | D-8

REPLY TO: 2200 DATE: 12/1/95

SUBJECT: Proposed Amendment to FSH 2209.22 (FS Range Improvement Handbook)

TO: Cheri Bashor
Steve Volesky

The changes that are proposed in this amendment relate to range fence bracing. The Little Missouri National Grasslands have considerable oil and gas development, which has byproducts such as surplus pipeing. Because of the availability of these materials, ranchers and fence contrators are requesting authority to use pipe as building materials for range fences. The use of steel pipe will extent the life of the fence and will reduce the cost of construction due to less construction time.

This proposal addresses the use of pipe for horizontal bracing and extending the maximum length of horizontal bracing for range wire fences. The following changes or additions are recommended for brace specifications:

1. Brace (line, corner and gate) length -------- 8 feet minimum
   (currently restricted to 8 feet)

2. Brace (line, corner and gate) materials)
   wood post---------- 4 inch diameter minimum
   (currently restricted to 4 inches)

   pipe (steel) ------ 1 1/2 inch OD minimum
   (1.5" I.D. / 1.6" O.D. and 2.72 pounds per foot minimum)
   (currently not authorized)

This office requests authorization to implement the above specifications on future fence construction projects. For questions call Gary Petik, Range Supervisor, (701) 842-2393.

Sincerely,

Lesley W. Thompson
DISTRICT RANGER

MESSAGE DISPLAY FOR CHERI K. BASHOR

To GARY PETIK:R01F08D08A
BC Cheri K. Bashor

From: Cheri K. Bashor
Postmark: Dec 06,95 10:56 AM Delivered: Dec 06,95 10:56 AM

Subject: Reply to:

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Reply text:
From: Cheri K. Bashor:R01F08A
Date: Dec 06,95 10:56 AM
gary, the designs & standards in the handbook are not requirements but merely recommendations on the best methods to use. use of new methods & designs is appropriate as long as all parties involved agree that they are appropriate. because of that, it isn't necessary to amend the handbook. since you have adequately analyzed this approach & feel it is an improvement in the existing recommendations, you have approval to implement.

Preceding message:
From: GARY PETIK:R01F08D08A
Date: Dec 01,95 1:32 PM

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110 - GENERAL. Improved distribution and control of grazing animals through the construction of range improvements has long been Forest Service policy. With expanding public needs and greater diversity of use, well constructed and properly located range improvements are becoming increasingly important.

Each and every range may not be maintained or developed to its optimum at any given time. It is, therefore, important that all personnel make every attempt to obtain full value, on the ground, for every dollar spent. Consultation with allotment permittees and careful field and office planning must therefore precede each project. Well planned and properly constructed improvements result in long life with low maintenance costs. Improvements constructed should be those listed in the development section of approved allotment management plans. Use the priority listing of allotments scheduled for development as a guide to selecting allotments for improvement work.

Proven standards and progressive construction and maintenance policies must be a portion of the range planning sequence. This handbook has been designed for field use in the Northern Region. Its use will hopefully aid Forest representatives in constructing and maintaining structural range improvements which not only accomplish the desired objective but also minimize conflicts with other multiple use services.

Field conditions seldom, if ever, conform to textbook designs. For this reason, the use of new methods, materials, and designs is encouraged. However, the ultimate criteria must be the judgment of the Forest officers involved depending upon the situation encountered on the ground. Worthwile contributions, along these lines, should be forwarded to the Range Management Staff Director for dissemination to other Forests.

Work safely--know the Health and Safety Code.

# STRUCTURAL RANGE IMPROVEMENT HANDBOOK

## CHAPTER 200 - FENCES AND FENCE STRUCTURES

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# CHAPTER 200 - FENCES

## 210 - FENCES AND FENCE STRUCTURES

211 - General Standards. A variety of fences are available to fit the needs of a site. The selection of a fence kind depends on such things as kind and class of livestock, topography, development and distribution of water, vegetative type, season of use, materials cost, and availability. No single type fence will fit all conditions. Barbed wire fences will be customary for range purposes. Pole-type fences may be justified in areas of heavy snowfall. Electric fences may suffice for temporary use. Need determines the type and standard.

1. Location. Internal and external boundaries of National Forest lands should be located before fencing, and fences should be on the line. Division and drift fences should be located to (1) contribute to efficient use of the forage and to livestock management, (2) take advantage of topography and natural barriers, (3) provide for ease of construction and maintenance, and (4) minimize interference with wildlife movements and management.

No fence will be constructed with Government funds on private land until an easement or deed for the right-of-way has been obtained from the owner.

It is important that fence lines in heavy snow areas be located or rechecked during late winter or early spring so that problem snowbank areas can be avoided.

The visual impact of a fence line is minimized by selecting a form, line, color, and texture that blends with the landscape. The fence selected must also meet range management objectives.

The most critical locations of fences are in the foreground and midground views along major travel routes and in vegetative openings. The visual impact of fence lines can be reduced by limiting the amount of fencing within view of a road or crossing open spaces. Where practicable, fences should be placed slightly inside vegetation surrounding such openings. Landforms may also be used to reduce visual impact. A fence located partway up a slope viewed against a landform and vegetative background, creates less visual impact than one silhouetted against the sky.

2. Alinement. Alinement of barbed wire fence is very important. Build wire fences as straight as possible because corners must be braced which increases construction and maintenance costs. Pole or log fences do not need bracing and therefore straight alinement is not so critical.

3. Clearing. Clearing the fence right-of-way wide enough for easy construction and maintenance access may be desirable. However, soil disturbance and clearing of vegetation for fence construction may cause undesirable deviations in color and texture. The degree of contrast varies with the form and extent of clearing and the extent of soil disturbance.

When clearing is done, color and texture deviation can be reduced by minimizing clearing and creating irregular or feathered clearing edges. Clearing methods which do not disturb the soil create least color contrast.

On boundary fences, all clearing must be on National Forest land. Remove logs or other obstacles in the fence line. Fell dead or leaning trees which may later fall across the fence.

4. Bracing. All corners and gates should be braced using methods shown in approved plans. Fence sections should end and be braced at both sides of a stream where water gap sections are installed. The number of braces depends on the terrain, but line braces will be installed at all breaks in alinement and at least each 1/4 mile. The line wires will be stretched and tied off at each brace. Wires may be stretched past a brace in a draw where a brace is used to hold wires down in the draw. Pole braces should at least be strip-peeled to reduce decay. Lodgepole braces should be treated. Top diameters should be at least 4 inches.

Where fences cross depressions, extra wires may be needed. Wires crossing a depression should be weighted down with rocks and tie-downs to take strain off the staples and posts. Where fences cross sharp ridges, the wires should be tied off and a new start made.

Fence corners over $90^{o}$ will be braced or constructed as shown on Plan 210-6.

212 - Types of Fences. Several kinds of fences are shown so the range manager can select the most suitable. Forest Supervisors may set fence standards within these guidelines.

212.1 - Post and Wire Fences

212.11 - Wood and/or Steel Post Fence. Fences may influence big-game movement. In Region 1, antelope are affected more than other species. The wire spacing guides shown on plan 210-1 are recommended where it is necessary to modify standard plans. Antelope normally crawl under rather than jump over fences; therefore, the height of the bottom wire is the most important feature. Modification of wire spacing may also be needed on migratory routes and in other similar special cases.

Three strands of barbed wire are usually adequate except where livestock pressures will be heavy. In such cases, the fourth strand should be added. In some cases involving private lands, it may be necessary to refer to State law for the description of a "legal" fence.

In heavy snow country, wooden posts should be spaced 1 rod apart to assure strength. Steel posts may be substituted for wooden posts where strength is not a controlling factor. However, in most cases, at least every fifth post should be wooden.

In light snow country, posts may be spaced up to 30 feet, using two or three stays between posts. Steel posts are usually satisfactory except for brace and gate posts, which should be wooden.

When crossing dry draws, all fence strands should be anchored to heavy rocks or other durable material with No. 12 or larger galvanized smooth wire.

212.12 - Rock Jack and Crib. This type of brace may be used where suited. Rock jacks require five 5-foot logs, 4 inches in diameter; floor material; and an upright post. Nail two pieces at a 60 degree angle to the upright post approximately 6 inches above the ground. Nail a third piece across the base of the angle to form an equilateral triangle. This forms the base for the floor. Nail two jacks to sides of the triangle at the base and overlap side logs approximately 6 inches; then nail to upright post to brace it in vertical position. Floor material can be cut to fit the base. Floor the base but do not nail. Large rocks are then placed in each corner and more rock added; 150 to 200 pounds is enough, do not overload.

212.13 - Wire Rock and Square Rock Cribs. On slopes, the ground should be leveled where the crib is set.

212.14 - Suspension Fence. This fence should be considered for allotment boundary and division fences in flat or undulating terrain to reduce costs. It should not be used in rough or steep areas. Its advantages are low construction and maintenance costs. It stands up well in moderately heavy snow and big-game areas.

Wooden line posts are spaced 80 to 120 feet apart with wire stays spaced 15 or 16 feet apart. Three to six strands of barbed wire are stretched taut (no more than a 3-inch sag between posts) and fastened to posts with nailed clips or "telephone staples." The wires must be free to move back and forth through the clip, thus the stays must not touch the ground. Treated wooden posts are preferred over steel posts. Posts should have at least a 5-inch diameter top.

212.15 - Water Gap Cable and Picket on Gate. This is suggested where fences cross live streams where high water is likely. Such structures are usually expensive and hard to install.

212.2 - Jack and Pole Fence. Jack and pole fences have both advantages and disadvantages when compared to wire fences. Initial construction costs are usually much higher, but a longer maintenance-free life may be expected. They hold up well in deep snow country, but the jacks have a tendancy to sink into soft ground.

This fence should be used where large quantitites of pole material are available on or near the fence line, where snow breakage and falling timber are a problem, and in areas where elk use is considerable.

All poles and jacks must be of sound material, well trimmed, and scalped on at least two sides. Douglas-fir should be entirely barked.

Jacklegs should have a minimum top diameter of 5½ inches and should be 6 feet long for normal fences. Larger material is hard to handle and is less durable. Jacks must fit tightly at the notch and be fastened with two 60d spikes clinched.

Poles should have a minimum top diameter of 3½ inches, with little taper. Notch poles to fit jacks, but thickness of poles must not be cut to less than 2½ inches. Poles should be fastened with one 60d spike. It is well to drill holes for the spikes in the pole before spiking. Poles should be placed on the uphill side of the jacks.

212.3 - Electric Fences. When a temporary fence for a short period of use is desired, consideration may be given to use of an electric fence. This type fence is most effective on moist sites and least effective on dry, rocky sites. It should never be built under powerlines. Vegetation must be kept from contacting the "hot" wire for the fence to be effective.

There are two types of electric fences -- single wire and two wire. The single wire is charged and when touched, grounds to the earth. For the two-wire type, it is necessary to charge only the top wire and ground the lower one. However, best results are obtained by using a double circuit controller and thus charge each wire separately.

It may often be cheaper, and more satisfactory in the long run, to install a regular three-wire fence instead of an electric fence.

Standard No. 9 smooth wire or barbed wire may be used. Barbed wire is more effective since it provides better contact with the animal's skin. Posts are usually spaced 30 to 50 feet apart and may be either wooden or metal.

All electric fences must have metal warning signs attached securely to the top wire frequently enough to warn people that the fence is charged. Because of possible hazards to humans, electric fences should be used only in areas not usually frequented by visitors.

212.4 - Letdown Fences. A letdown fence is similar to an ordinary fence, except that the wires are not fastened directly to the posts. It is effective in deep snow country and to permit game to pass in the off-season. Two types are common.

212.41 - Stay Let-down. Wires are fastened to stays which in turn are fastnened to set posts with wire loops. The wires are not as tight as regular post and wire fences and two or more stays are used between posts to keep wires from tangling when fence is laid down.

The upper wire loop is fastened to the set post near the top. It is looped over the stay to hold the fence upright. The bottom loop may be stapled solidly to both the post and stay.

The fence should be in sections of not more than 20 rods. Where the fence runs upslope, each section should be left tied at the upper end to prevent it from being pulled downslope by snow.

212.42 - Staple Let-down. Secure fence wire conventionally at brace panels or corner posts. Sometimes there must be provision for slacking off wires as shown in the plans. On the other posts, drive two staples horizontally, one above and the other below each wire, and leave 3/4-inch projection. Insert a third staple in the loops to hold the wire in place. Use staples at least 1-1/2 inches long.

212.5 - Woven Wire Fence. This fence will ordinarily be used only for fencing experimental exclosures, water developments, portions of sheep driveways, or sheep pastures. The bracing and most other instructions for barbed wire fences apply. Standard 26-inch high woven wire hung 2 to 4 inches above the ground, should be used where sheep-tight fences are desired. Place one or two strands of barbed wire above the woven wire if cattle or horses are on either side of the fence. In such cases, a 12-inch space should be allowed between the barbed wire and woven wire, except in antelope country where this space shall not be less than 14 inches.

Posts should be spaced 1 rod apart. Wooden stays may be advisable in heavy snow country, since severe winter damage often occurs.

Woven wire is usually stretched by bolting two 2x4's securely over the woven wire to form a clamp. Bolts should be at 8-inch intervals to prevent slippage. Stretch wire reasonably tight; avoid overstretching to the point that mesh squares collapse. Staple both ways from the center of stretched section so that equal tension will result.

212.6 - Post-Pole and Post With Pole and Wire Fences. These fences have limited use; however, they may be used for esthetic value around recreational or administrative sites, or along scenic roads. A pole rail on top of posts may be advantageous in reducing maintenance around horse pastures or areas heavily used by people. Top rails may be good when fencing small areas since less corner bracing is needed. The post-pole and wire fence, or modifications of it, is recommended on those portions of big-game/livestock exclosures which permit game use but exclude livestock. Specifications should generally be the same for standard post and wire fences, but may be adjusted to meet special situations.

212.7 - Figure "4" Fence. This type of fence is useful where post-holes are hard to dig and native wood and rock are immediately available. Refer to barbed wire fences for spacing of wires and general instructions. Figure "4's" are built with three posts 4 inches or more in cross section. These three posts are assembled as follows: Nail the base of the upright post to the ground post in such a way as to allow not less than 18 inches of the ground post to extend beyond the wires on the side opposite the upright and brace. The back end of the ground post should be 6 to 8 inches off the ground. This is held off the ground by the brace when it is nailed into place. The top end of the brace should be nailed as high as possible on the upright post. Use two 50d nails in the end of each post. Drive nails at a binding angle. Round material should be notched at each joint. Any of the regular braces are suitable for use with this fence.

212.8 - Log Fence. (Worm Fence and Log and Block Fence). These fences are rarely utilized because of high construction costs. However, they are good in heavy snow and timber areas where reduced maintenance may justify construction costs.

212.9 - Tree Fences

212.91 - Wire on Trees

1. Minimum d.b.h. for live trees scabbed and used in the fence are: line brace or corner, 10" d.b.h. minimum; post 4" d.b.h. minimum.

2. Never staple or wrap wire in contact with living trees. Spike a 3-inch post or 2-inch plank to the tree as a nailing strip. Staple wires to the nailer. At tie-off points, three or four nailers around the tree are required.

3. Use long spans -- about 4 rods.

4. Use stays at 8-foot intervals.

5. Locate fence so wire will tend to pull against nailer. Thus, on line fences, wire will weave between trees. If the fence pulls away from any tree because it was taken past the wrong side, it should be tied to the nailer with No. 12 wire. Do not use staples.

6. Attach a small pole to the wires at all game crossings so game can see and avoid the fence.

212.92 - Poles on Trees. Poles should be spiked directly to the trees. Spikes must be long enough to secure the pole to the tree. These fences may vary in location and alinement for ease of construction.

213 - Fencing Materials

1. Posts

a. Wooden Posts. Juniper and western redcedar are the only species common to Region 1 which may be used for set posts without preservative treatment. Western redcedar split posts must be old-growth wood. Lodgepole pine has good preservative penetration and retention qualities, especially when pressure treated. Use only fully treated or butt treated posts. When butt treated posts are used, the treated portion will extend 6 inches above the ground. Generally, line posts should have a 3-foot butt treat and brace and corner posts a 3- to 3½-foot butt treat.

Top diameters for line posts should be at least 4 inches for treated softwood and 3 inches for juniper. Use 5- to 6-inch top diameters for gates, corners, and braces. Minimum lengths should be 6½ feet for line posts and 7 to 7½ feet for corner or brace posts.

It is usually more economical to purchase treated posts than to cut, peel and treat them by force account. Post treating should, therefore, be undertaken only where post material is abundant and cheap and where labor is not a factor.

Jacklegs may be made from almost any species. Each leg should be scalped to the sapwood on two sides so bark will peel. Douglas-fir should have almost all bark removed.

b. Steel Posts. Steel posts may be used where post strength is a lesser factor, or in rocky country where drilling is necessary to set a post. Standard T posts with a steel anchor plate should be used. These posts weigh about 1.5 pounds per foot. Standard length

is 5½ feet. Fence wires should be fastened to steel posts only by standard steel clips manufactured for this purpose. Steel posts must be driven until tops of the anchor plates are imbedded 4 to 6 inches.

2. Wire

a. Barbed Wire. Barbed wire must be galvanized. For most range uses, 12½-gage high tensile strength (90,000 to 105,000 p.s.i.) will be used. In locations where strength is less important, 13½-gage and some 14½-gage wire is available. Barbed wire comes in 80-rod spools; 12½-gage weighs 81 pounds, and 13½-gage weighs 75 pounds per spool.

b. Woven Wire. Standard woven wire fencing has 10-gage top and bottom wires with 12½-gage intermediate and stay wires. Height varies from 26 to 47 inches. Wire must be galvanized. Stay wires 6 inches apart are recommended for most situations.

c. Smooth Wire. Smooth wire is easier to handle than barbed and should be used for all gate loops and for tying wood stays. Size can vary but No. 9 galvanized is better for gate loops and No. 12 for tie wires.

3. Poles. Poles should be straight, with slight taper, and of the most durable species available. They should be at least strip-peeled to prolong life. Top diameter should be at least 3 inches for rails and 4 inches for braces. Pressure treated poles are best for bracing.

4. Stays. Stays can be wood or twisted wire. If wooden, they are fastened to the barbed wire with smooth wire or staples. Wood stays should be at least 2 inches in diameter, in deep snow country. When used, wooden stays should set solidly on the ground and extend at least 4 inches above the top wire. Manufactured wire stays are available from General Services Administration.

5. Staples, Nails, and Spikes. Galvanized staples, 1½ inches long (72 per pound) are best for general use. With harder woods, a shorter staple may suffice.

Common steel nails are usually used. Galvanized nails are available and may be better for some fences.

Nails most used in fencing are:

| | | |
|---|---|---|
| 16d common | 3½ inches long | 49 per pound |
| 20d common | 4 inches long | 31 per pound |
| 30d common | 4½ inches long | 24 per pound |
| 40d common | 5 inches long | 18 per pound |
| 50d common | 5½ inches long | 14 per pound |
| 60d common | 6 inches long | 11 per pound |
| 7- by 5/16-inch spikes | | 7 per pound |
| 8- by 5/16- or 3/8-inch spikes | | 4 & 6 per pound |

213.1 - Materials Needed for the Different Types of Fences

1. Post and Wire. The following materials are required for 1 mile of 3- or 4-wire fence with 1 wire gate, 1 corner, and diagonal bracing every ¼ mile (16½-foot spacing):

20 corner and brace posts 7 feet long, 5-inch minimum top.
312 line posts 6½ feet long, 4-inch minimum top.
7 rails 8 feet long, 4-inch minimum top (horizontal gate and corner braces).
10 rails 12 feet long, 4-inch minimum top (diagonal gate and corner braces).
17 80-rod rolls barbed wire (includes brace wire); 13 rolls for 3-wire fence. Reduce rolls of wire needed by one if smooth wire is used for bracing.

45 pounds 1½-inch galvanized staples.
3 pounds 40d nails.
320 stays, wire or wooden (2-inch minimum top for wood).

2. Rock Jack and Crib. One mile of this type fence would seldom be built. The following materials are needed to build one rock jack and crib:

1 post, 4 feet long, 6-inch diameter.
5 poles, 5½ feet long, 4-inch diameter.
1 pound 40d nails.
Cut flooring material to fit base, but do not nail down.

3. Square Rock Crib. The following are required for one square rock crib:

14 poles, 4½ feet long, 5-inch diameter for crib.
5 or 6 pieces of wood, 4½ feet long, of varying widths but with a minimum thickness of 5 inches for crib floor.

4 posts, 4½ feet long, 6-inch diameter.
5 pounds 60d nails for nailing crib material to post. Floor is not nailed.

4. Suspension Fence. Materials for 1 mile of 3- or 4-wire suspension fence with 1 wire gate, 1 corner, and line bracing every ¼ mile (100-foot spacing between posts):

20 corner and brace posts, 7 feet long, 5-inch minimum top.
52 line posts, 6½ feet long, 4-inch minimum top.
7 rails, 8 feet long, 4-inch minimum top (horizontal gate and corner braces).
10 rails, 12 feet long, 4-inch minimum top (diagonal gate and corner braces).
16 80-rod rolls barbed wire; 12 rolls for 3-wire fence.
300 feet 9- or 12-gage smooth wire for brace wire.
460 stays, wire or wood (2-inch minimum top for wood).
4 pounds 40d nails.
2 pounds 1½-inch galvanized staples; 45 pounds if wooden stays are used.
24 pounds telephone staples (GSA item).

5. Jack and Pole Fence. The following materials are required for 1 mile of fence (1 rod between jacks):

640 6-inch diameter, round logs, 6 feet long (jack legs or posts).
1600 4-inch diameter round logs, 18 feet long (fence poles).
64 4-inch diameter round logs, 20 feet long (bracing).
350 pounds 60d common nails.

6. Electric Fence. Materials needed for 1 mile of fence with one gate, one corner, and short line brace every ¼ mile (25 feet between posts):

13 corner and brace posts, 6½ feet long, 5-inch minimum top.
200 line posts, 6½ feet long, 4-inch minimum top.
7 rails, 8 feet long, 4-inch minimum top (horizontal gate and corner braces).
4 80-rod rolls barbed wire.
260 feet 9- or 12-gage smooth wire for brace wire.
3 pounds 40d nails.
215 insulators.

7. Letdown Fence (Stay type). The following materials will be needed to construct 20 rods of 4-wire fence (16½-foot post spacing). This fence should be in sections of not more than 20 rods.

4 corner and brace posts, 6½ feet long, 5-inch minimum top.
18 line posts, 6½ feet long, 4-inch minimum top.
2 rails, 8 feet long, 4-inch minimum top (H-type short line braces).
1 80-rod roll barbed wire.
115 feet 9- or 12-gage smooth wire for braces.
60 stays, 2-inch minimum top.
4 pounds 1½-inch staples.
Nails for braces.

8. Woven Wire Fence. The same materials will be needed for 1 mile of this fence as with the standard post and wire fence except for rolls of wire:

16 20-rod rolls of 26-inch woven wire.
4 80-rod rolls barbed wire. (Only needed if cattle and horses are present.)

9. Post and Pole. The following materials will be needed to construct 20 rods of fence (8-foot post spacing).

44 line posts, 6 feet long, 4-inch minimum top.
42 rails, 8 feet long, 6-inch minimum or 21 rails, 16 feet long.
42 rails, 8 feet long, 4-inch minimum or 21 rails, 16 feet long.
10 pounds 60d nails.

10. Figure "4" Fence. Materials needed for one figure "4" post are as follow:

2 posts, 5½ feet long, 4-inch minimum top.
1 post, 6 feet long, 4-inch minimum top.
6 50d nails.

11. Worm Fence. Following is a list of materials for approximately 20 rods of fence covering a distance on center line of 22 feet, 3 inches.

93 pieces 8 inch to 10 inch logs, 16 feet 0 inches long. Horizontal sections.
62 pieces 6 inch round logs, 5 feet 6 inchs to 6 feet 6 inches long. Tie posts.
32 rocks or 32 pieces 10 inch round logs by 4 feet 0 inches. Sills for posts.
7 pounds #14 malleable galvanized iron wire. To make fence ties.

12. Log and Block Fence. List of materials for approximately 20 rods of fence covering a distance of 12 feet per panel length.

83 pieces 8 inch to 10 inch logs, 16 feet 0 inches long. Horizontal sections.
83 pieces 8 inch to 10 inch logs, 4 feet 2 inches to 4 feet 9 inches long. End logs.
4 pounds #14 malleable galvanized iron wire. To make fence ties.

214 - Fencing Equipment

1. Posthole Diggers. Diggers work better when ground is moist but not muddy; thus, digging is usually easiest in the spring.

a. The Two-Handled Hand Digger. These dig fast in grassland types where there is little rock.

b. Shovel and Bar. Basic handtools in rocky ground.

c. Tractor-Mounted Augers. Several types are available; some rigidly mounted and some free swinging. The free-swinging types drill straight regardless of slope. Neither is well adapted to steep or rocky ground.

d. Portable Power Augers

(1) Portable Self-Contained Power Augers. There are various kinds on the market.

(2) Chain Saw Augers. Several chain saws have power take-off and auger attachments. These work well in spring and early summer on ground that is not too rocky or underlain with hardpan.

(3) Power Unit on Cart. This auger is driven by an enclosed flex shaft.

2. Post Drivers

a. Hand Operated. These may be purchased or built. The heavier two-man drivers are best for rocky hard driving.

b. Mechanical. Several types are available for mounting on tractors, trailers, or skids. They need two or three men to operate. Most Ranger Districts cannot afford to own such machines, but they might be rented for major fencing jobs.

3. Wire Stretchers. There are several kinds of ratchet-type wire stretchers. Most are better than the block-and-tackle type. A widely-used model has a cable and ratchet arrangement and weighs 6 to 8 pounds.

4. Tamping Tools. Where posts are set, dirt must be firmly tamped back in the holes. However, a common fault is to tamp in too much dirt at once. Tamp in only a few inches at a time, especially at the bottom of the hole. Dirt tamps better when moist.

There are many good tamping tools. The most commonly used is a digging bar with a round tamping head on the handle. Another good one uses a 2-foot length of 1-inch pipe fitted over a straight shovel handle. Wooden handles are less tiring to workmen than metal handles.

5. Tool List. The following is a tickler list for a three-man fencing crew:

| | |
|---|---|
| Axes, double-bit, 3½ pounds | 2 |
| Axes, single-bit, 2 pounds | 1 |
| Bags, water, 2-gallon or canteens | 2 |
| Bar, digging | 1 |
| Bar, tamping | 1 |
| Bar, wrecking | 1 |
| Digger, hand | 1 |
| Files, 10-inch | 2 |
| Hammers, claw | 3 |
| Hammers, 4-pound | 2 |
| Pliers, wire | 3 |
| Saw, chain | 1 |
| Saw, carpenter | 1 |
| Shovels, long-handled, round point | 2 |
| Stones | 2 |
| Stretcher, wire | 1 |
| Pick | 1 |

Miscellaneous tools:

| | |
|---|---|
| Brace | 1 |
| Chisel, wood, 1-inch or larger | 1 |
| Expansion bit | 1 |
| Wood augers, set | 1 |
| Knife, draw | 1 |
| Square, carpenter's | 1 |
| Rule, 6-foot, metal in case | 1 |
| Wrench, 18-inch, adjustable | 1 |
| Wrench, 12-inch, adjustable | 1 |
| Wrench, 10-inch, adjustable | 1 |
| Wrench, 18-inch, pipe | 1 |
| Wrench set, combination open-end box | 1 |

215 - Maintenance. The objective of maintenance is to keep fences at, or as near as possible to, the standard to which they were constructed. To this end, fences should be thoroughly maintained annually. Broken wires will be spliced, pulled staples or broken ties will be replaced, and wire will be restretched as needed. Badly rotted or broken sections of log or pole fences will be replaced. All trees and logs which have fallen across fences will be removed. All high risk old live or dead trees, within falling distance of the fence, should be removed. Under present policy, this is a permittee job, but it is the Ranger's responsibility to see that an adequate job is performed. Right-of-way clearings will be maintained as needed to permit continuing access.

220 - GATES, CATTLE GUARDS, STILES

221 - Gates. There should be gates at all trails, roads, and livestock crossings, near most corners, and on major ridgetops and creek bottoms. There must be at least one gate every half-mile. Painted gateposts (white or yellow) are more visible from a distance. Gate close signs may be desirable. Signs with the wording "Please Close Gate between June 15 and October 15" (use dates applicable) are preferred over metal "Please Close Gate" signs. Better results in keeping the gate closed during the grazing season have been reported by using the dated sign.

Wire gates will continue to be most common in range fences. At road crossings and other frequently used routes, swinging gates or cattle guards should be installed. Manufactured aluminum gates are practical where esthetic values are not involved. Brush-through gates may be effective. All gates should be at least 12 feet wide; those on roads should be at least 14 feet wide.

221.1- Pole Gates. These are expensive to build, but are appropriate at administrative sites, along scenic roads, and at recreation areas. Material must be uniform and completely peeled. Workmanship must be good.

221.2 - Board Gates. This type of gate will normally be used only for corrals.

221.3 - Wire Gates. In places where large numbers of livestock are to pass through a fence, build two standard gates with a brace panel between them instead of one long gate.

Wood stays are better than wire stays in gates, if properly installed. Always use smooth wire for gate loops. Barbs must be removed if necessary to use barbed wire.

221.4 - Metal Gates. Several types of commercially manufactured gates are available. In most instances, these are more economical and practical than pole gates. They are light weight, strong, and do not warp. Gates with riveted panels are more durable than those with spot-welded panels. Hangers and hardware for hanging usually come with the gate.

222 - Cattle Guards. Prefabricated cattle guards are usually best because of cost, maintenance, and utility. Treated timber abutments are adequate for light traffic and cost less, but concrete must be used for heavy traffic.

See the Forest Engineer for cattle guard plans with either concrete or timber abutments.

There are various types of temporary cattle guards. Automobile tires held flat by cables may serve as a temporary cattle guard for light pressure locations. Temporary guards should not be allowed to become semipermanent but should be completely removed when they have served their purpose.

A special cattle guard-type passageway for antelope has been developed and used successfully in Wyoming by BLM. Antelope and most other game readily cross these passes, but livestock are successfully turned back. For best results, locate the pass at a fence corner, on an obvious antelope trail, or at a jog in the fence line. Set the guard low in the ground on treated timbers, such as crossties, and bank the dirt up well on each end.

223 - Stiles and Fence Ladders. These will be used mainly for access to enclosures, and for fence crossings at campgrounds. Since human safety is involved, be sure to keep ladder cleats, handrails, and step treads in good repair.

230 - CHECKLIST FOR FENCE CONTRACTS

1. General

a. Contractor shall furnish all (include appropriate items) labor, material, tools, equipment, transportation, and supervision to completely install, in good workmanlike manner, barbed wire fencing, including gates, hereinafter referred to as fences.

b. Government shall furnish (include items supplied by the Government). If materials are suppled, show point of delivery and time when material may be picked up.

c. The fence line will be shown on an attached map. The actual ground location will be staked, flagged, or otherwise marked prior to bidding.

2. Materials. Include detailed description of materials specified for use for each purpose.

3. Construction Details

a. Line Posts

(1) Maximum and average spacing in feet.

(2) Depth to drive or set in ground.

(3) Alignment of line posts (straight - vertical).

(4) Wood posts to be tamped firmly.

b. Bracing

(1) Plan to use in each situation (refer to plan drawings).

(2) Spacing and location of bracing structures.

(3) Posts to be set in line with fence--firmly tamped.

c. Gates

(1) Where they will be located.

(2) Specifications and plans to follow for each gate.

d. Stays

(1) Specifications--wood or wire, size, etc.

(2) Spacing.

e. Fasteners

(1) Specifications on staples and steel post tie wires.

(2) Manner of application (may refer to illustrations). Staple so wire may slip through staple. Do not kink wire.

f. Barbed Wire

(1) Specifications, gauge, etc.

(2) Number of strands.

(3) Spacing of wires above ground.

(4) Variations to meet special situations, such as creeks where extra strands may be needed.

g. Anchors

(1) Crossing depressions (refer to plans and illustrations).

(2) Where needed for supplemental reinforcing corners.

h. Clearing

(1) Width through timber (relation to flagged line).

(2) Removal of dead and leaning trees.

(3) Disposal of cut material.

i. Construction Methods

(1) Wire never to be kinked or nicked.

(2) Wire taut with due consideration for contraction and expansion.

(3) Not more than one-fourth mile of wire stretched at one time.

(4) Dead end at corners and gates with wire ends wrapped around posts and twisted back on stretched wire.

j. Signs

(1) Where and how signs will be installed.

4. Method of Measurement for Payment. Gates paid for separately? Unit of measurement.

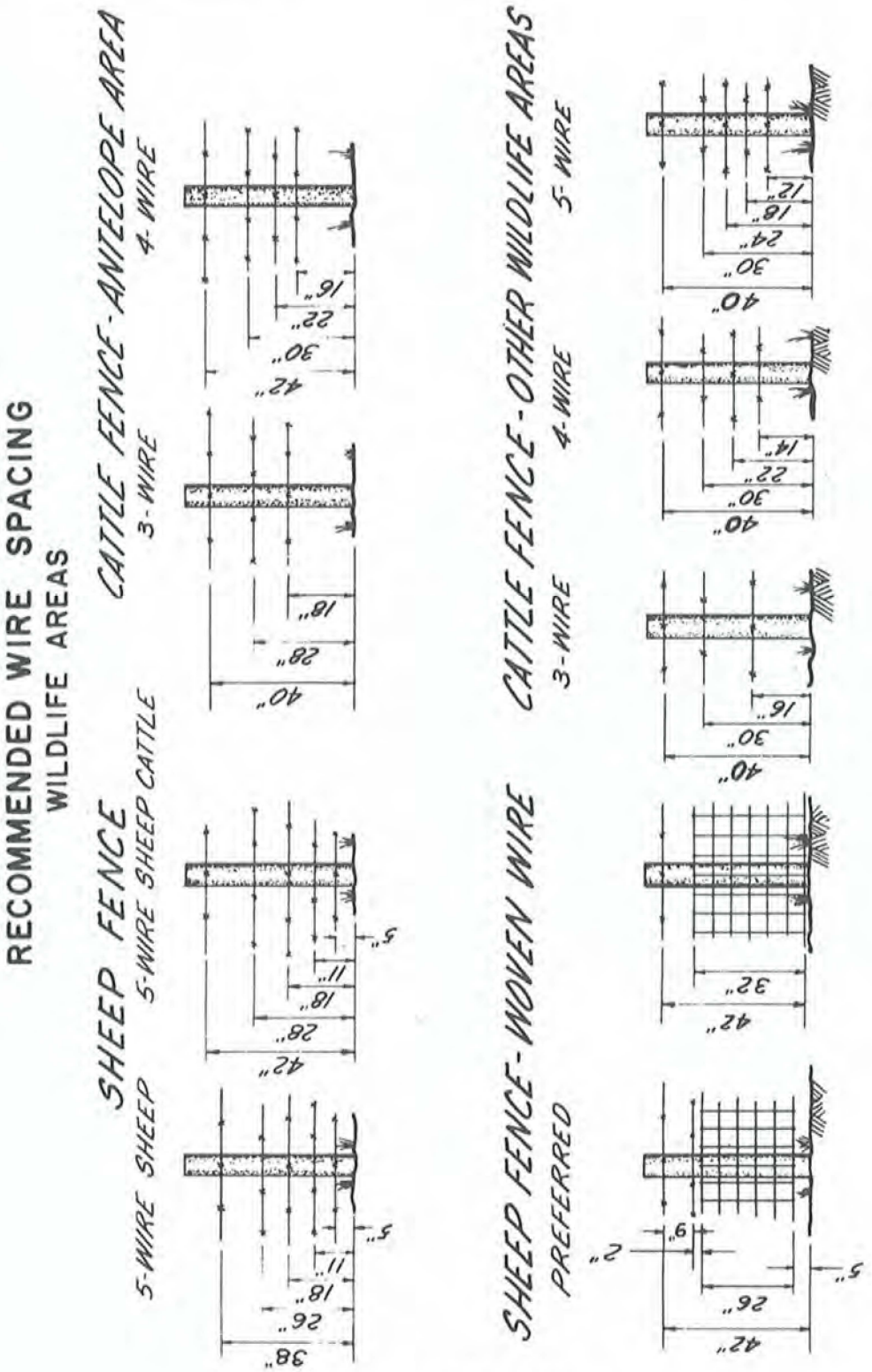
5. Basis for Payment

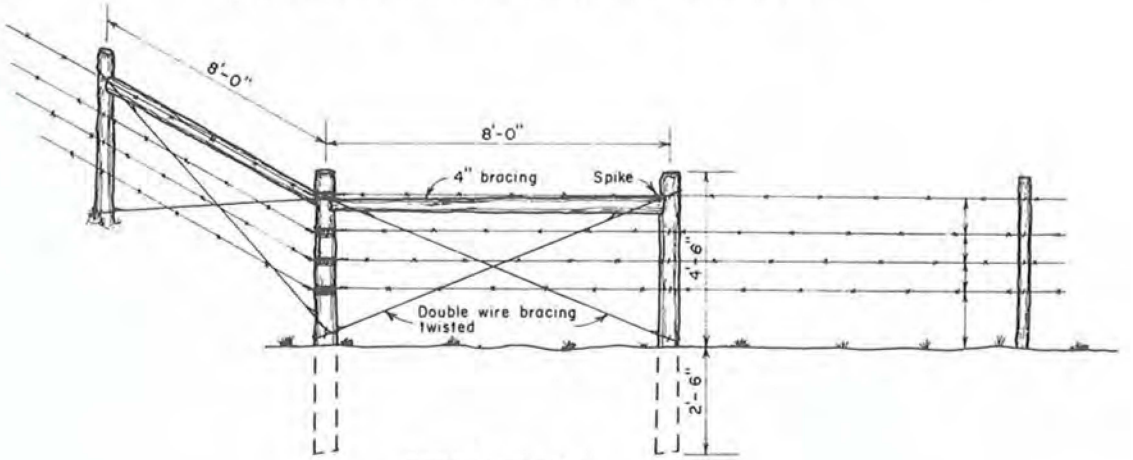
a. One payment.

b. Partial payments--minimum amount and frequency.

6. Other Items. It may be necessary to provide for special construction features using jacks across rocky stretches or bog areas, and for use of trees as line posts.

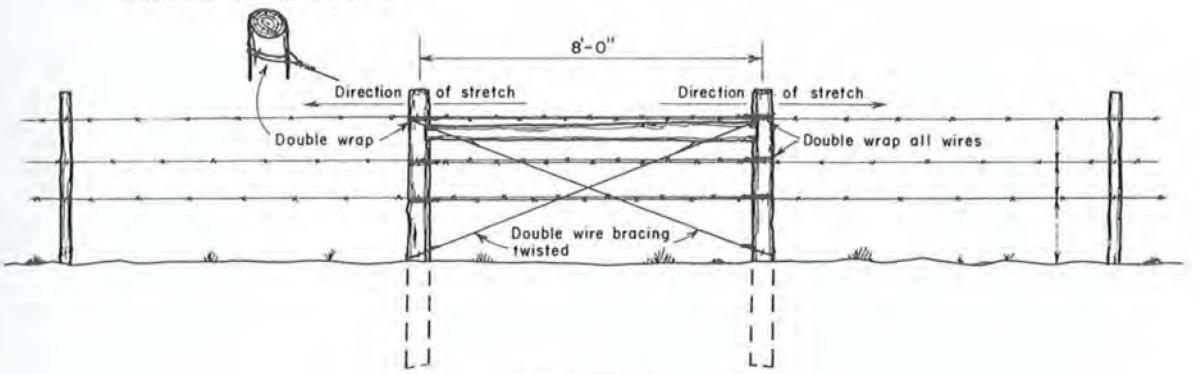
## 290 - STRUCTURAL PLANS



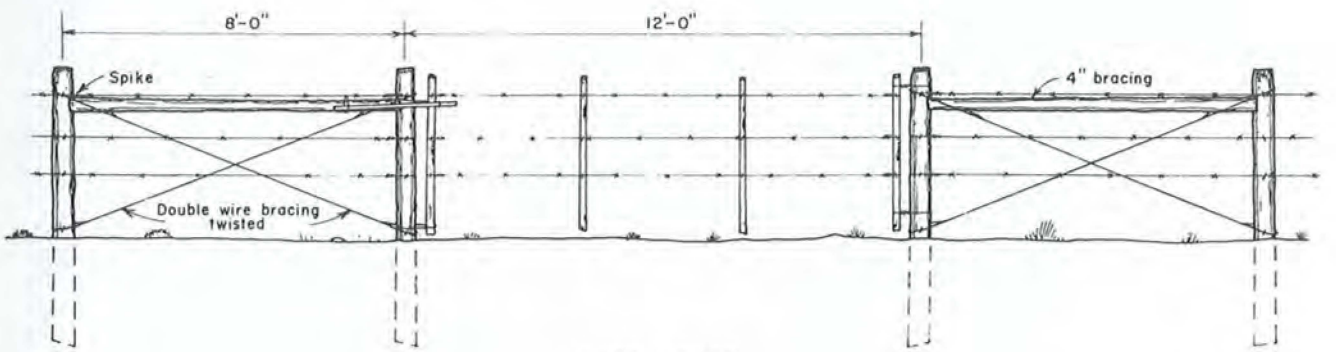



CORNER BRACE

DOUBLE WRAP DETAIL




LINE BRACE




GATE BRACE

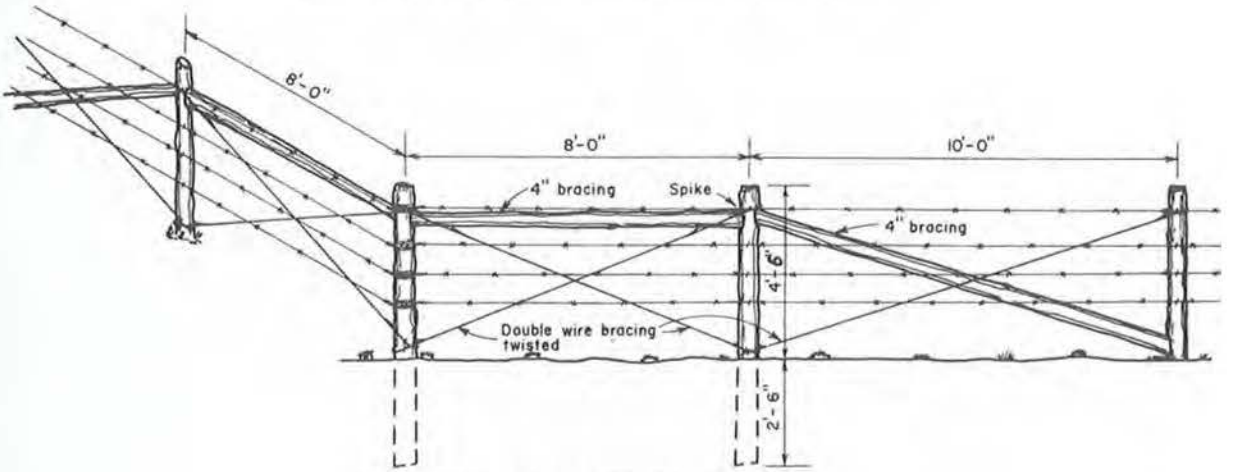
Note

1. Peeling of posts optional
2. Dap braces into posts
3. Spike braces to posts

# WIRE FENCE BRACES

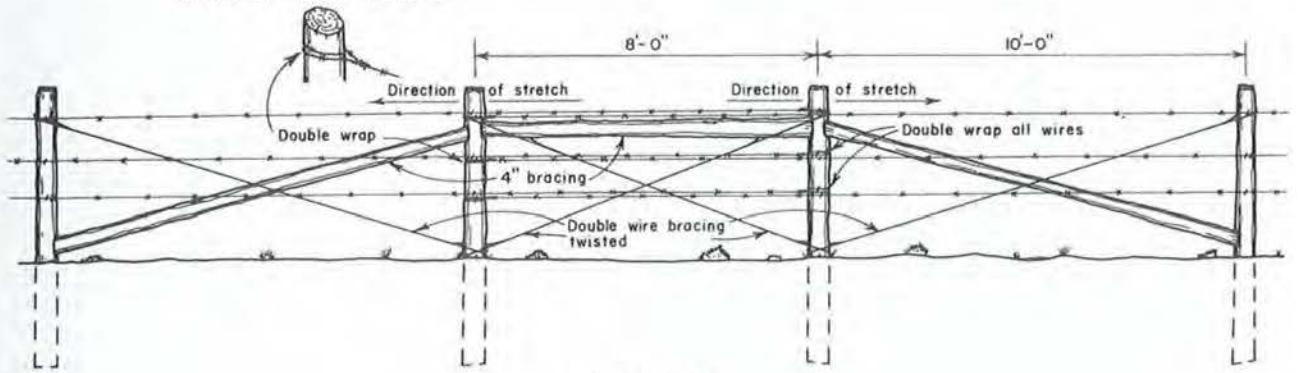
(SHORT FENCE OR LIGHT PULL)

PLAN 210-2

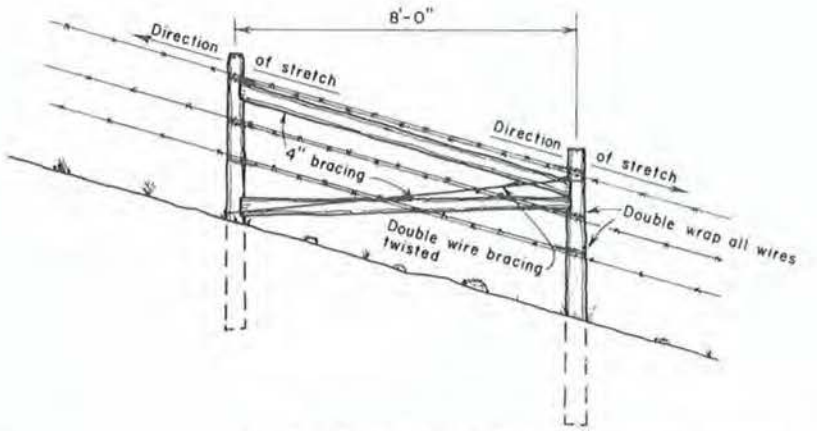



CORNER OR GATE BRACE

DOUBLE WRAP DETAIL




LINE BRACE

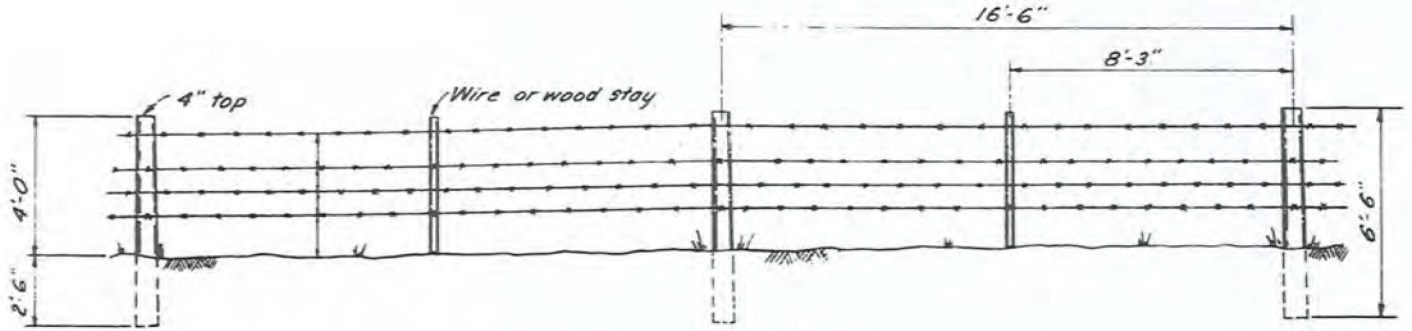



LINE BRACE FOR SLOPES ABOVE 30 PERCENT

Note:
1. Peeling of posts optional
2. Dap braces into posts
3. Spike braces to posts

# WIRE FENCE BRACES
(EXTRA STRENGTH)

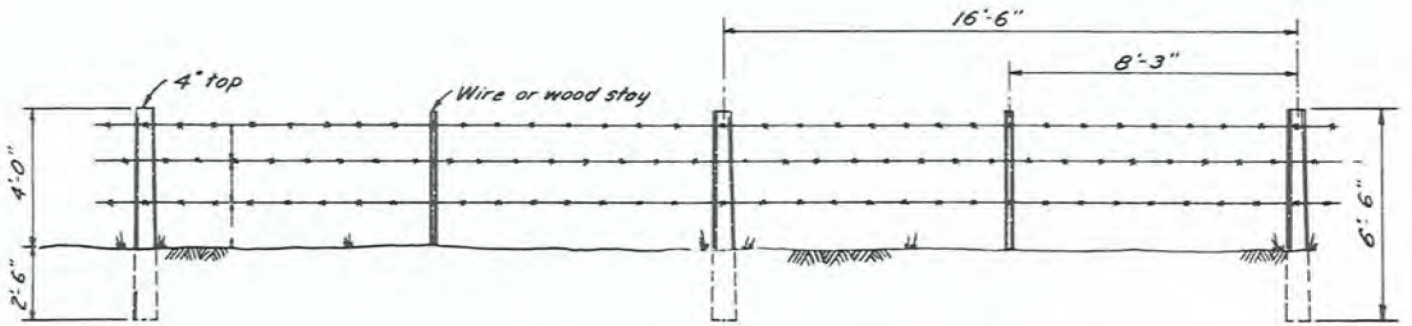
PLAN 210-3




SECTION OF LINE FENCE
4-WIRES & STAYS

NOTE:

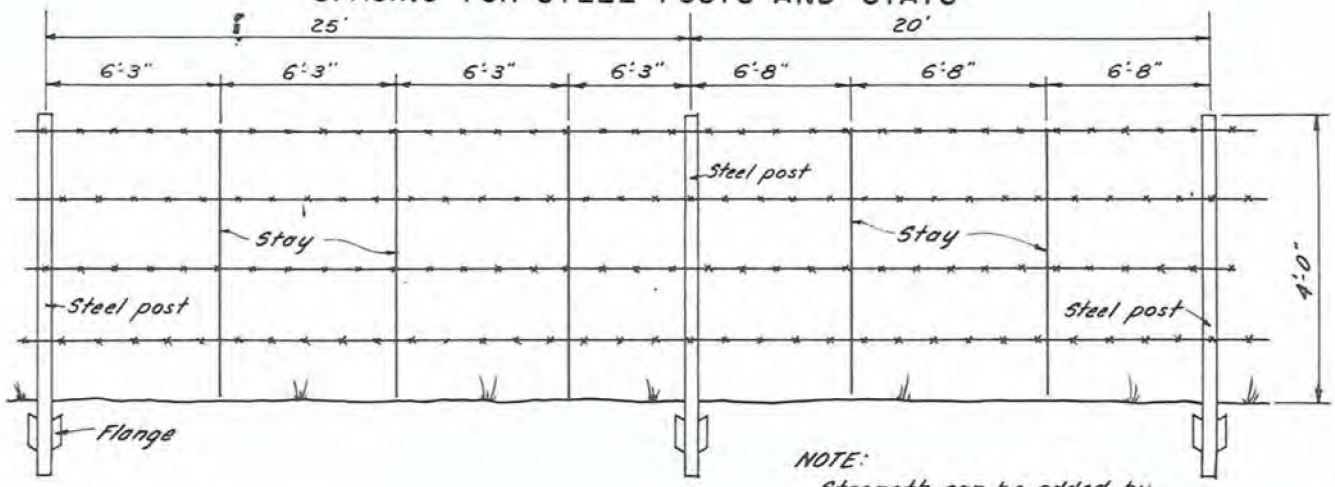
Some spacing and post length applies to steel fence posts. Two equi-distant stays are good construction.




SECTION OF LINE FENCE
3-WIRES & STAYS

PLAN 210-4

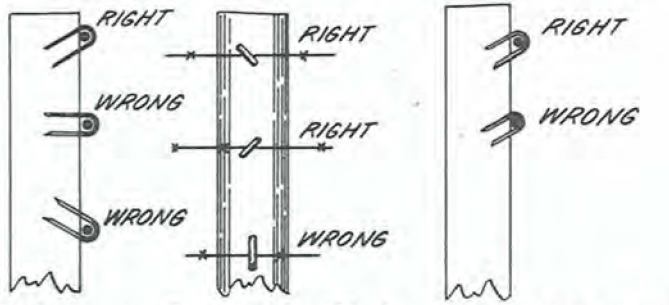
## SPACING FOR STEEL POSTS AND STAYS




NOTE:
Strength can be added by substituting a wooden post for every 5th. or 10th. post.

NOTE:
Use same spacing and post length for wood post.

### USE OF STAPLES

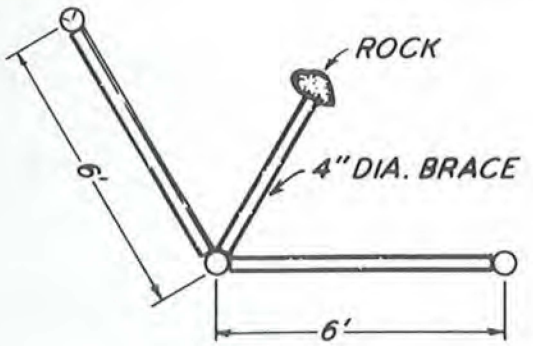



Drive Staples at angle. Leave wire loose in Staple.

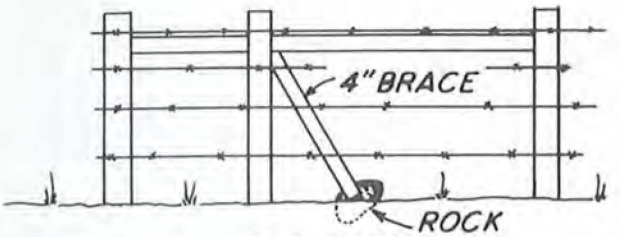
Do not drive Staple parallel to side of post.

Leave Wire loose in Staple.

PLAN 210-5

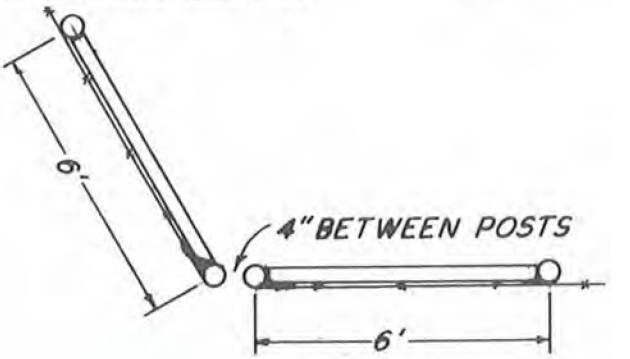



PLAN

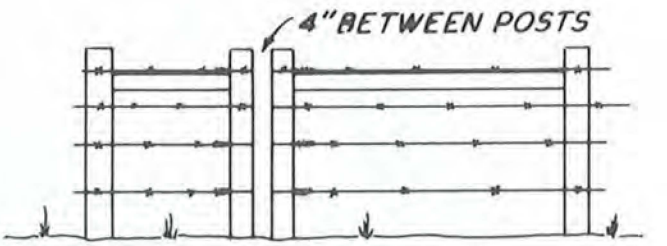



ELEVATION

## ANGLE POST DEADMAN

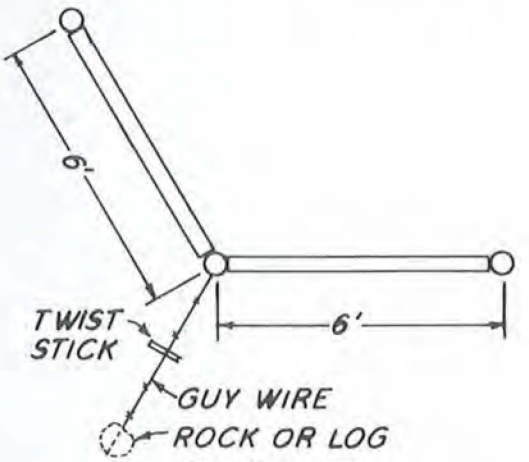



PLAN

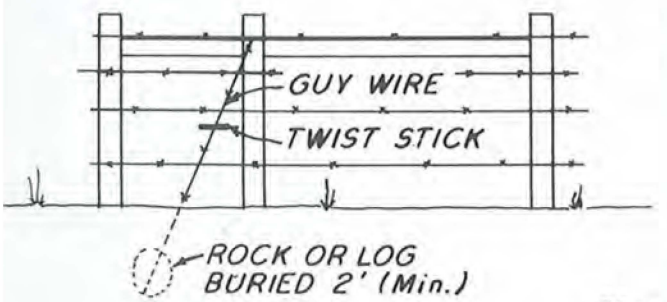



ELEVATION

## DOUBLE POST CORNER

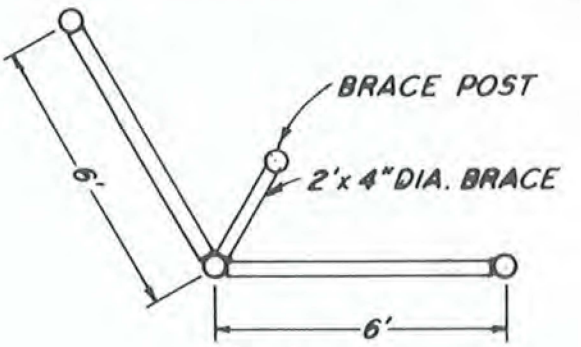



PLAN

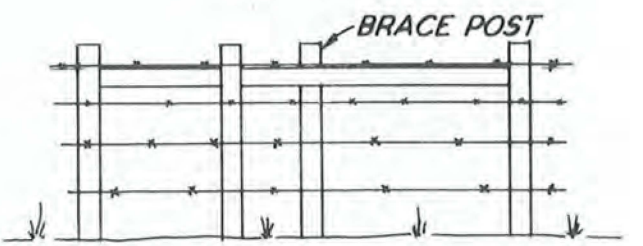



ELEVATION

## WIRE DEADMAN




PLAN




ELEVATION

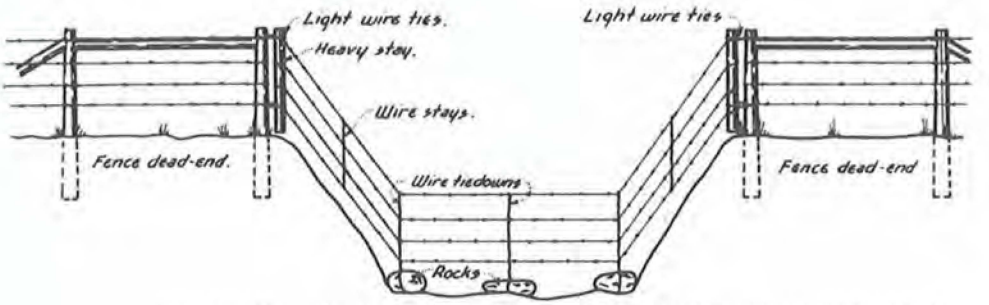
## INTERIOR POST DEADMAN

*NOTE:*

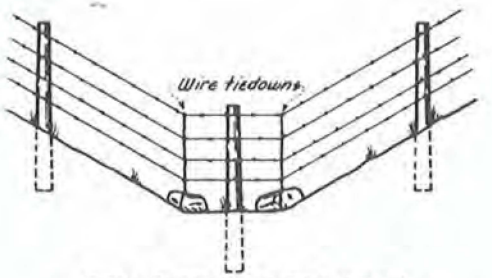
*Bracing wire is not shown on these drawings but should not be omitted in construction.*

Plan 210-6

## DEADMAN FOR ANGLES OVER 90°



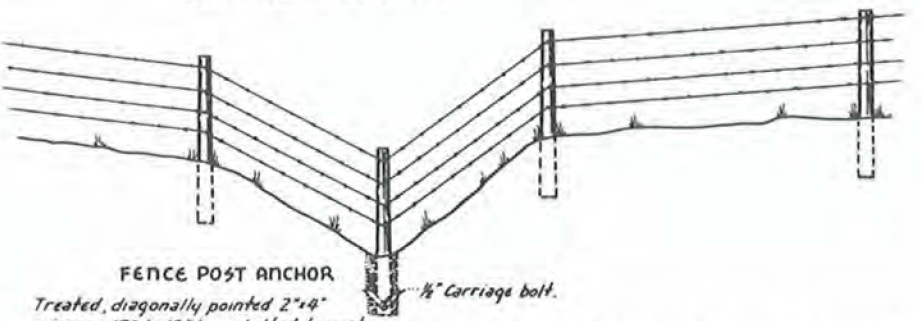

DETACHABLE WIRE PANEL WITH ROCK ANCHORS FOR DEEP WASHES & LIVE STREAMS.




ROCK ANCHORS IN DRY DRAWS
*Square rock cribs also useful.*

NOTES.

*Panels of woven wire or board can be used. Panels built separate, and tied to fence with light wire..... then, during floods, ends can break loose and not disturb main fenceline.*

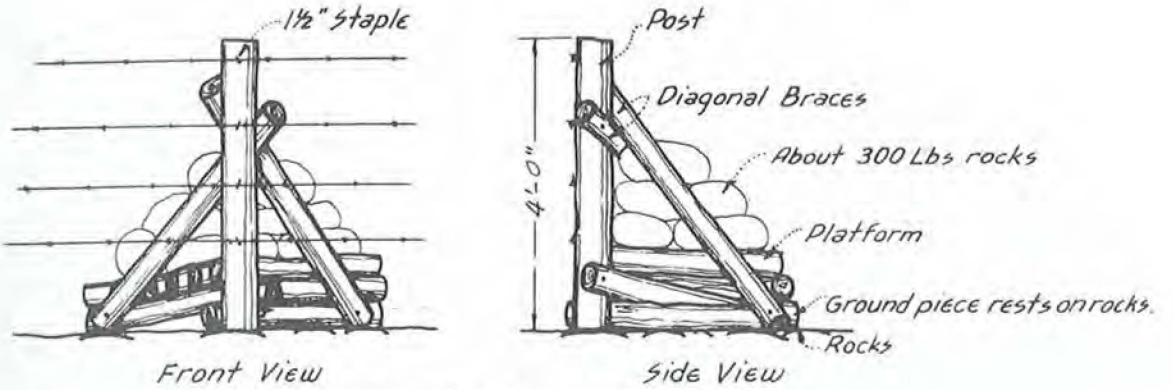



FENCE POST ANCHOR

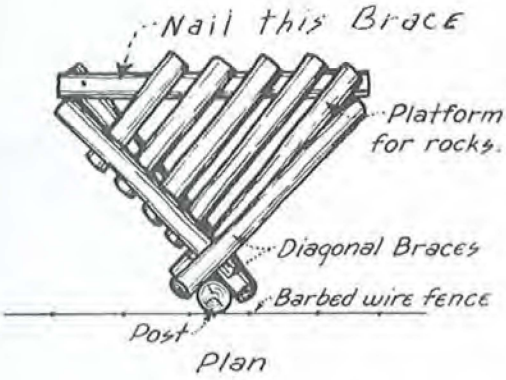
*Treated, diagonally pointed 2"x9" pieces, 12" to 16" long, bolted to post and wedged tightly into sides of posthole & covered with well-tamped gravel & earth.*

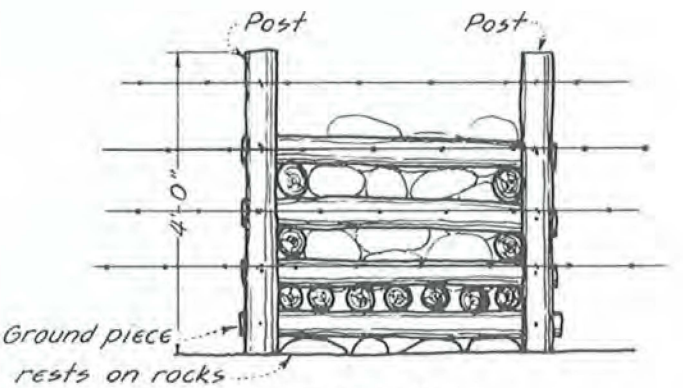
## BARBED WIRE FENCE
## FOR CROSSING STREAMS & DRAWS

PLAN 210-7




ROCK JACK AND CRIB




SQUARE CRIB

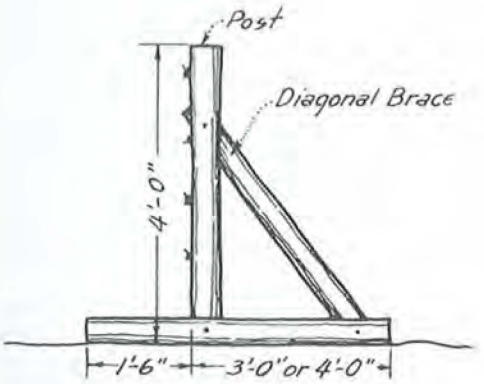
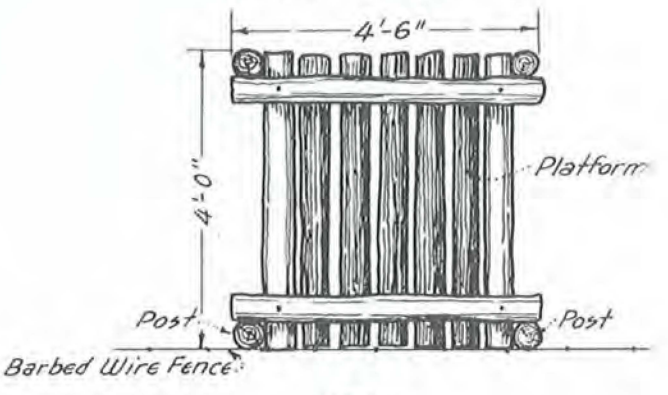
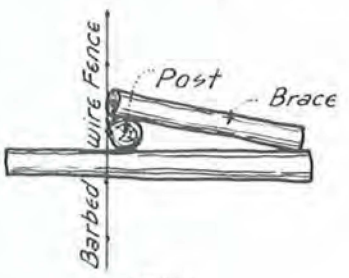



FIGURE FOUR POST

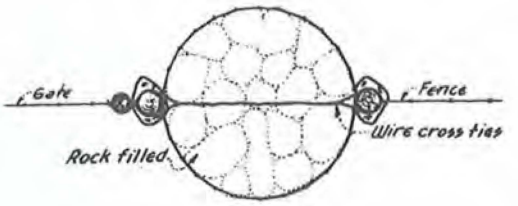



NOTES
Spike members together.

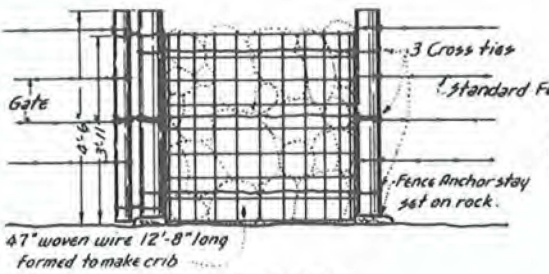
# WIRE FENCE BRACES

PLAN 210-8

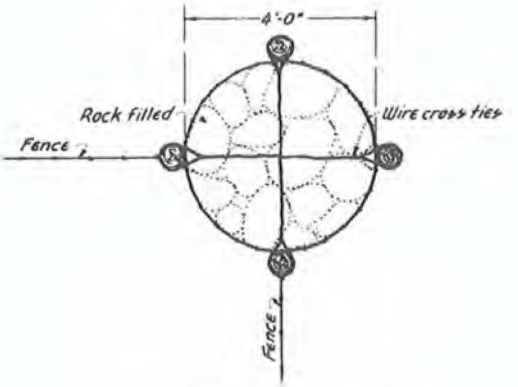



PLAN

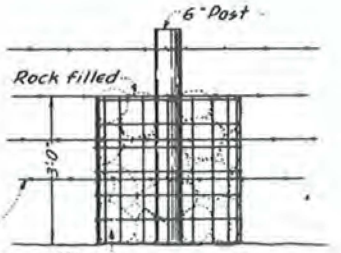
ROCK CRIB GATE POST



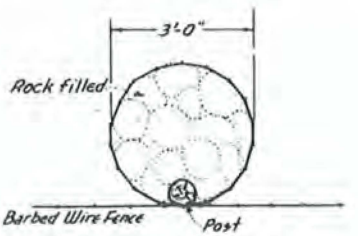

ELEVATION




ROCK CRIB CORNER POST
PLAN




ELEVATION

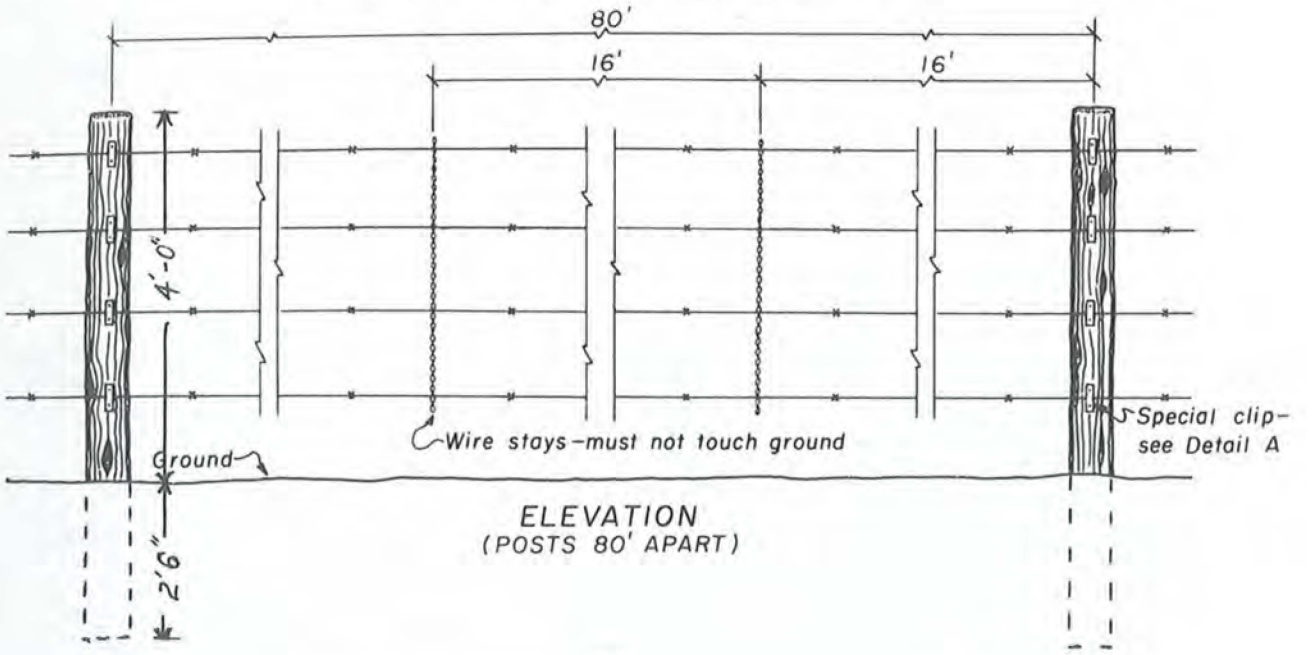



ROCK CRIB LINE POST
PLAN

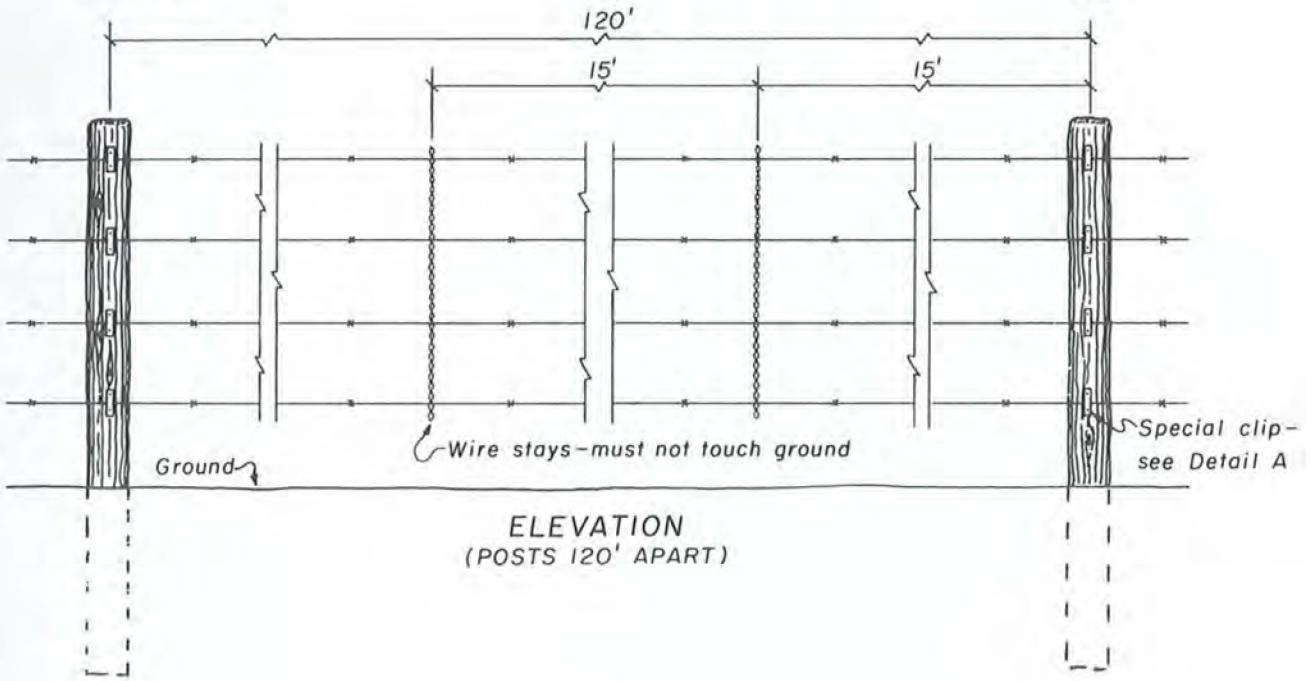
NOTES.
Splice netting ends together to form crib, and staple together.
Level bed for crib.

## WIRE FENCE BRACES
## (WIRE ROCK CRIBS)

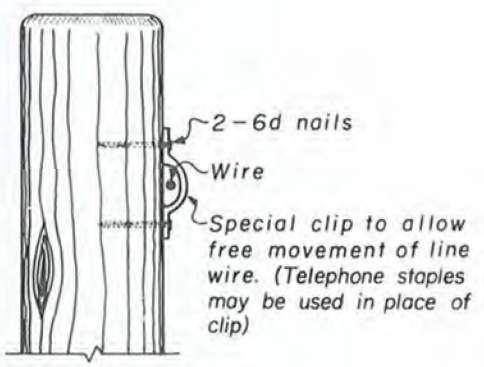
PLAN 210-9




ELEVATION
(POSTS 80' APART)



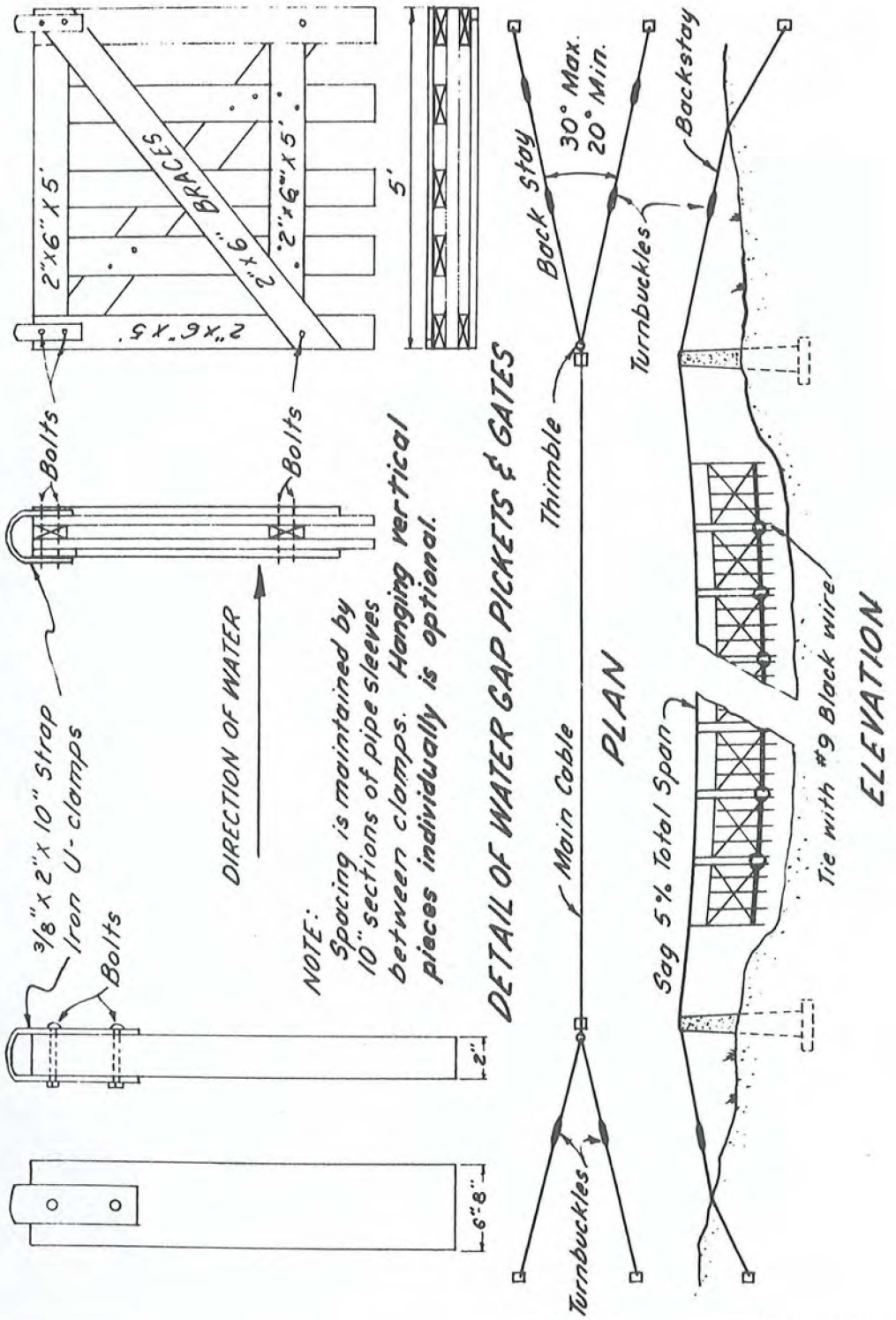

ELEVATION
(POSTS 120' APART)




DETAIL A

SUSPENSION FENCE

PLAN 210-10

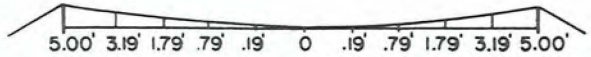

2"x6"x5'
BRACES
2"x6"x5'
2"x6"x5'
5'
Bolts
Bolts
3/8"x2"x10" Strap
Iron U-clamps
Bolts
DIRECTION OF WATER
NOTE:
Spacing is maintained by
10" sections of pipe sleeves
between clamps. Hanging vertical
pieces individually is optional.
2"
6"-8"
DETAIL OF WATER GAP PICKETS & GATES
Back Stay
30° Max.
20° Min.
Turnbuckles
Backstay
Thimble
Main Cable
PLAN
Turnbuckles
Sag 5% Total Span
Tie with #9 Block wire
ELEVATION

PLAN 210-11

# SUSPENDED CABLES

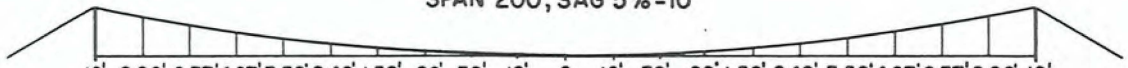
| CABLE SIZE INCHES | LOAD PER FT. | | SPAN | SAG | % | S LBS.-HOR. PULL | |
|---|---|---|---|---|---|---|---|
| | CABLE ONLY | TOTAL WGT. PER FT. | | | | CABLE ONLY # PER FT. | TOTAL LOAD # PER FT. |
| 3/4" | .90# | 20# | 100' | 5' | 5 | 230# | 5100# |
| 3/4" | .90# | 20# | 200' | 10' | 5 | 460# | 10200# |
| 7/8" | 1.25# | 20# | 300' | 15' | 5 | 956# | 15300# |

SPAN 100', SAG 5% = 5'



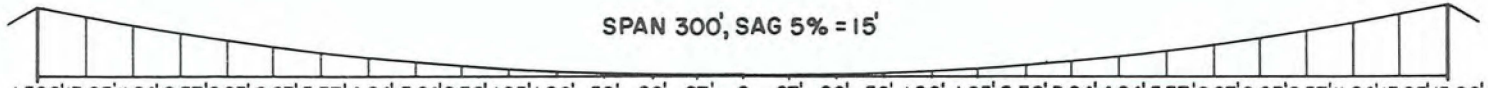

TANGENT OFFSETS 10' INTERVALS

SPAN 200', SAG 5% = 10'



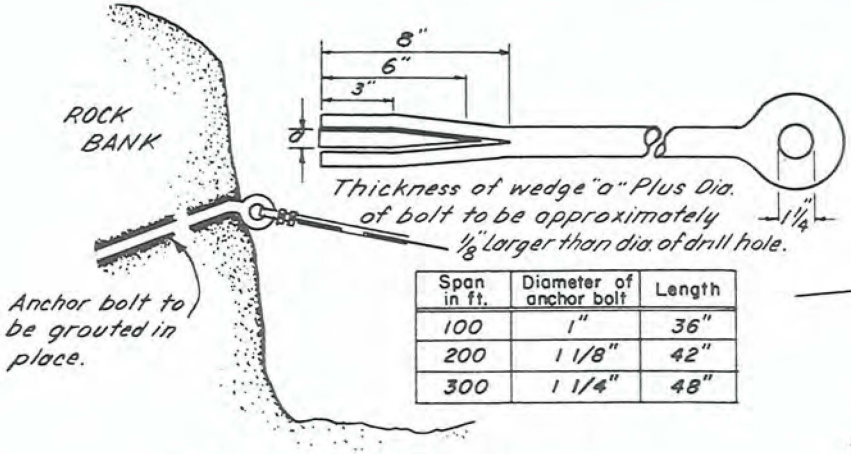

TANGENT OFFSETS 10' INTERVALS

SPAN 300', SAG 5% = 15'



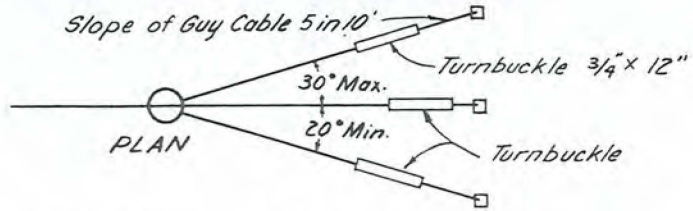

TANGENT OFFSETS 10' INTERVALS

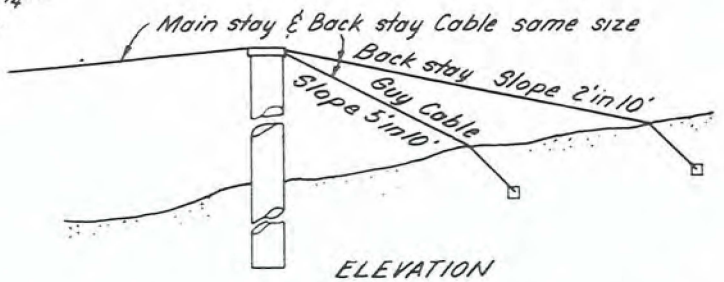
SCALE

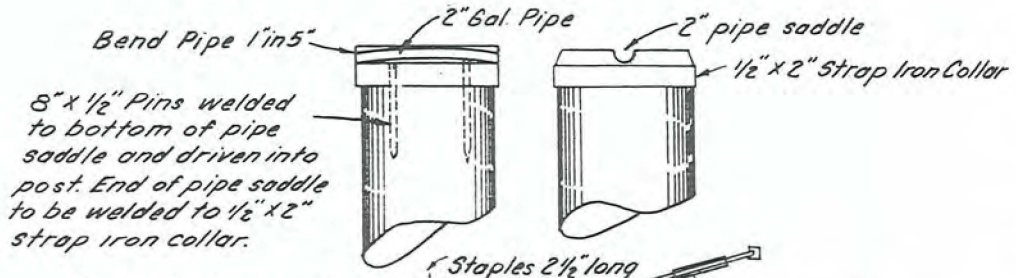



| Span in ft. | Diameter of anchor bolt | Length |
|---|---|---|
| 100 | 1" | 36" |
| 200 | 1 1/8" | 42" |
| 300 | 1 1/4" | 48" |

Detail for Anchor Bolt where main cable is to be Anchored to rock cliffs.





2" Gal. Pipe
2" pipe saddle
Bend Pipe 1" in 5"
1/2" x 2" Strap Iron Collar
8" x 1/2" Pins welded to bottom of pipe saddle and driven into post. End of pipe saddle to be welded to 1/2" x 2" strap iron collar.
Staples 2 1/2" long
Wrap Cable around Post and Staple
Turnbuckles
Turnbuckle

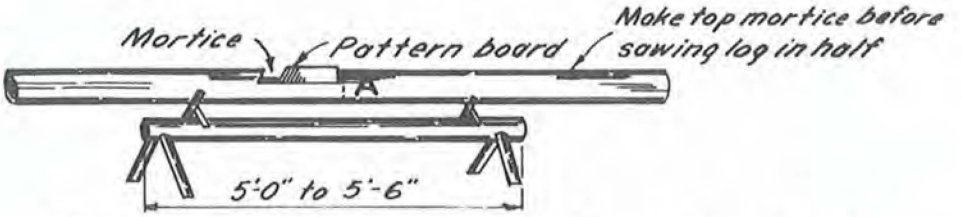
DETAIL OF SADDLE FOR WOOD POST FOR PIERS

| HEIGHT IN FEET | SPANS 100' | 200' | 300' |
|---|---|---|---|
| | DIAMETER | | |
| 8' | 10' | 12' | 12' |
| 10' | 10' | 12' | 12' |
| 12 | 10' | 12' | 12' |
| 14 | 10' | 12' | 12' |

Juniper or Pine post
Height above ground and diameter

PLAN 210-13

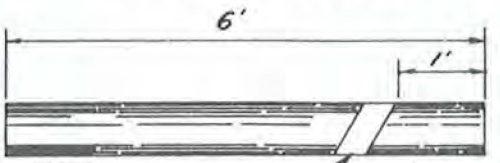
# JACK LEG FRAMING HORSE




Place pegs in horse so jacks to be made will not pinch saw when double jack is cut at "A"

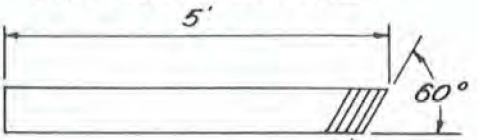
Make horse from light or dead material.

## POST & NOTCH

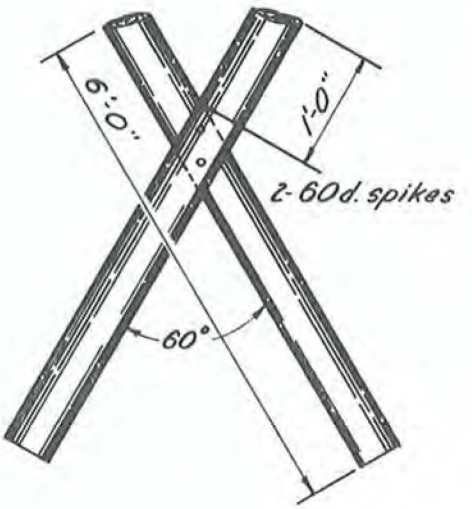



Width of notch determined by size of post. This should fit tightly.

## PATTERN BOARD




1" markings to gauge notch width



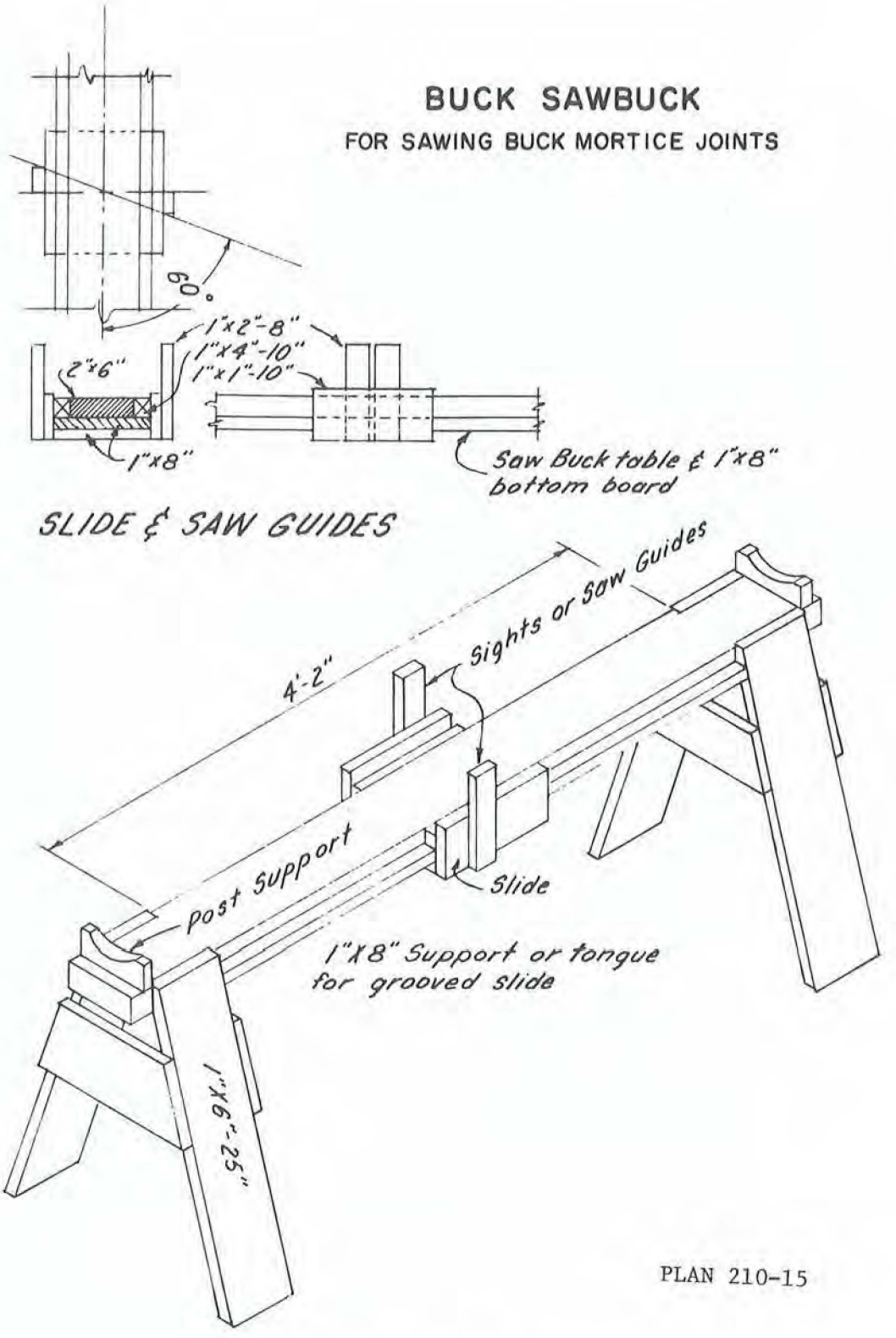

NOTE:
Both jacks to be cut the same.
For steep side hills make long Jack-Leg for low side.

JACK LEG FRAMING HORSE

PLAN 210-14

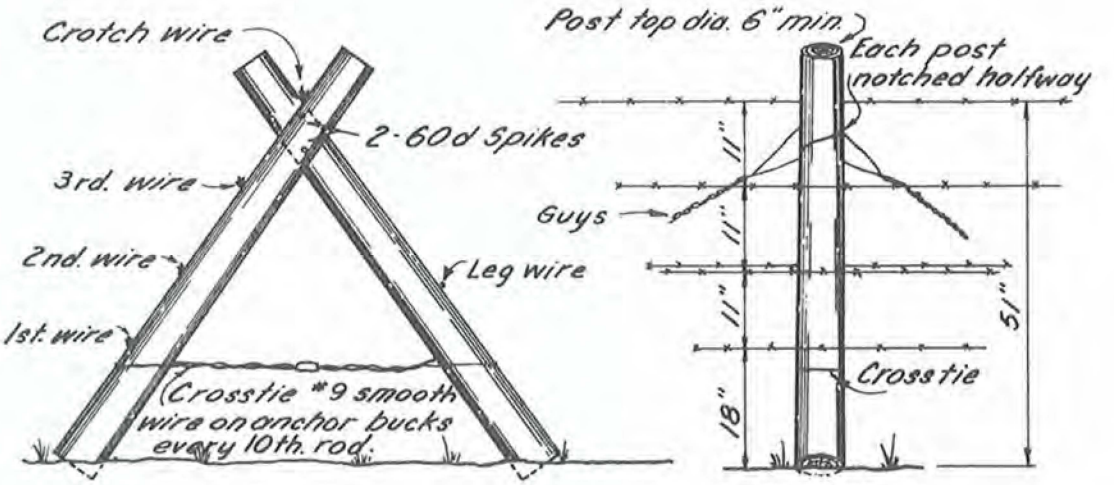
# BUCK SAWBUCK

## FOR SAWING BUCK MORTICE JOINTS




PLAN 210-15

# JACKLEG AND WIRE FENCE




WIRE SPACING & CROSSTIE FOR ANCHOR JACK

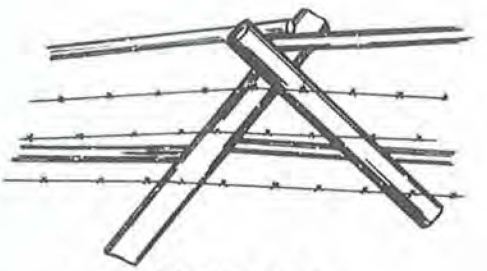
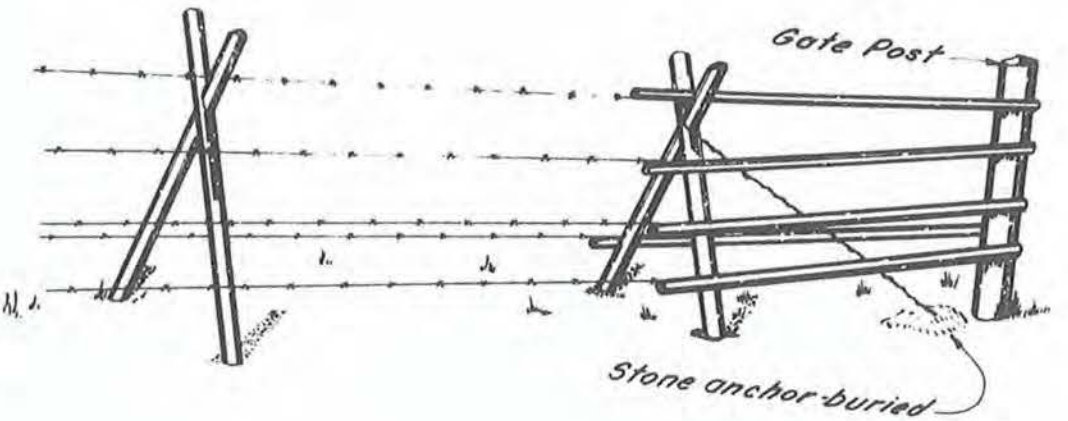
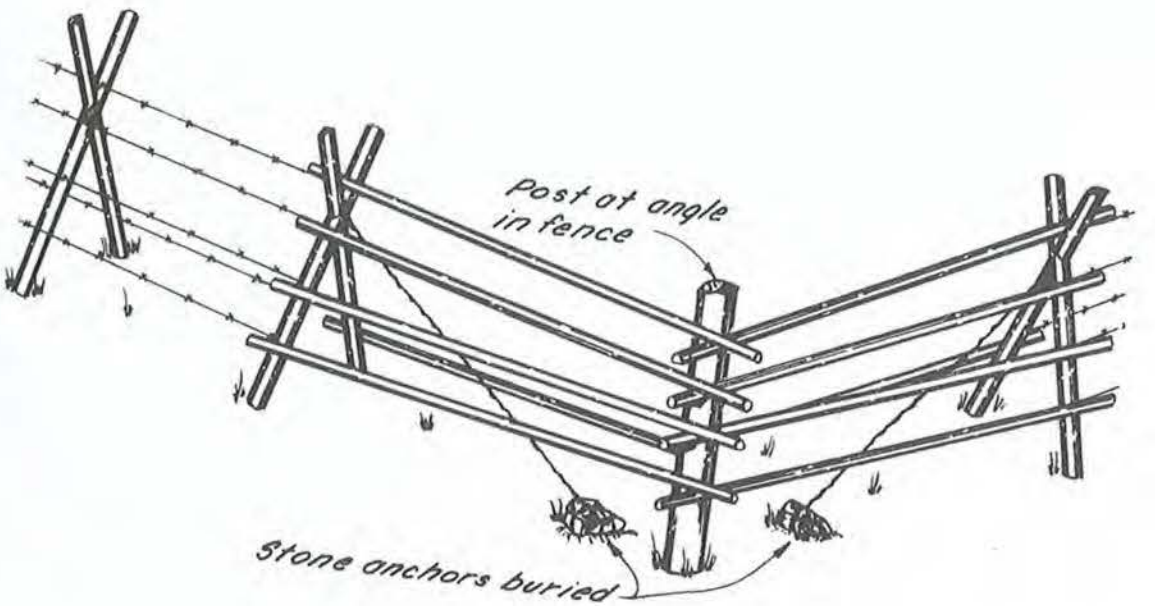


FIGURE A

USE OF RIDER POLE INSTEAD OF WIRE

PLAN 210-16


Gate Post
Stone anchor buried


Post at angle in fence
Stone anchors buried

PLAN 210-17

## TWO METHODS OF ANCHORING FENCE BUCK

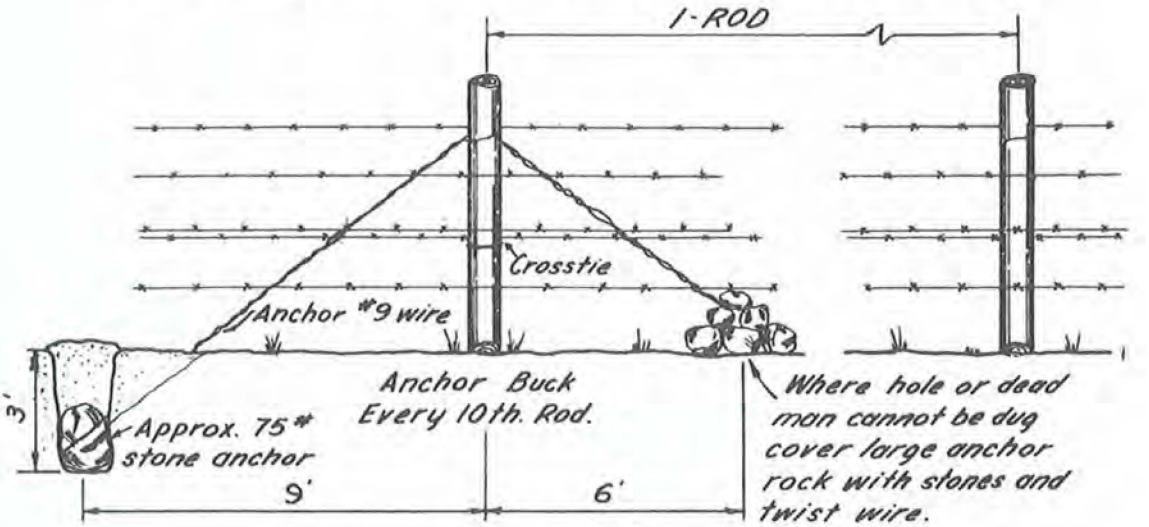
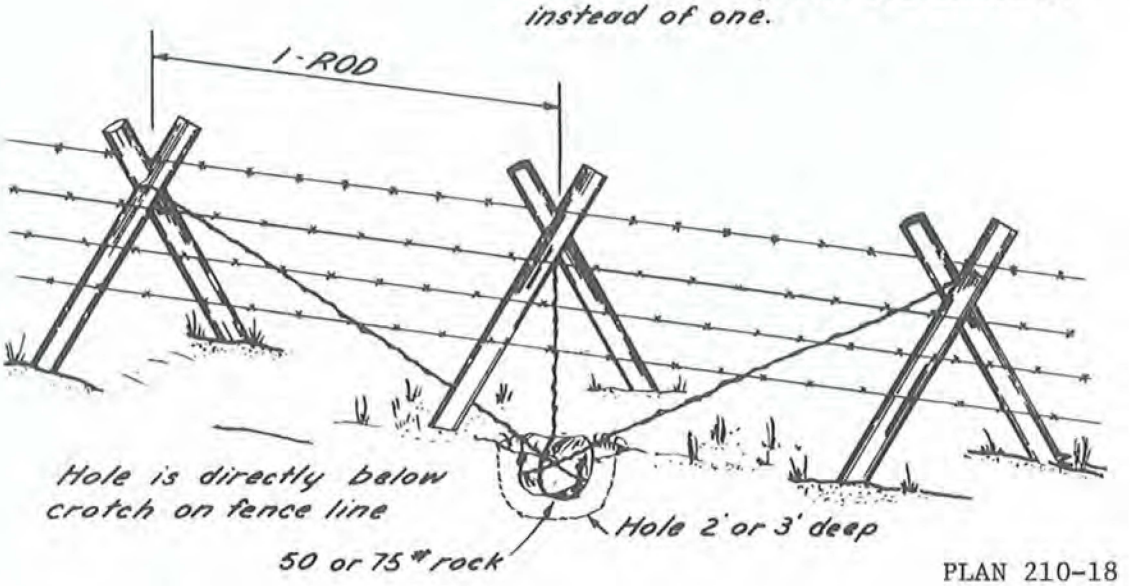
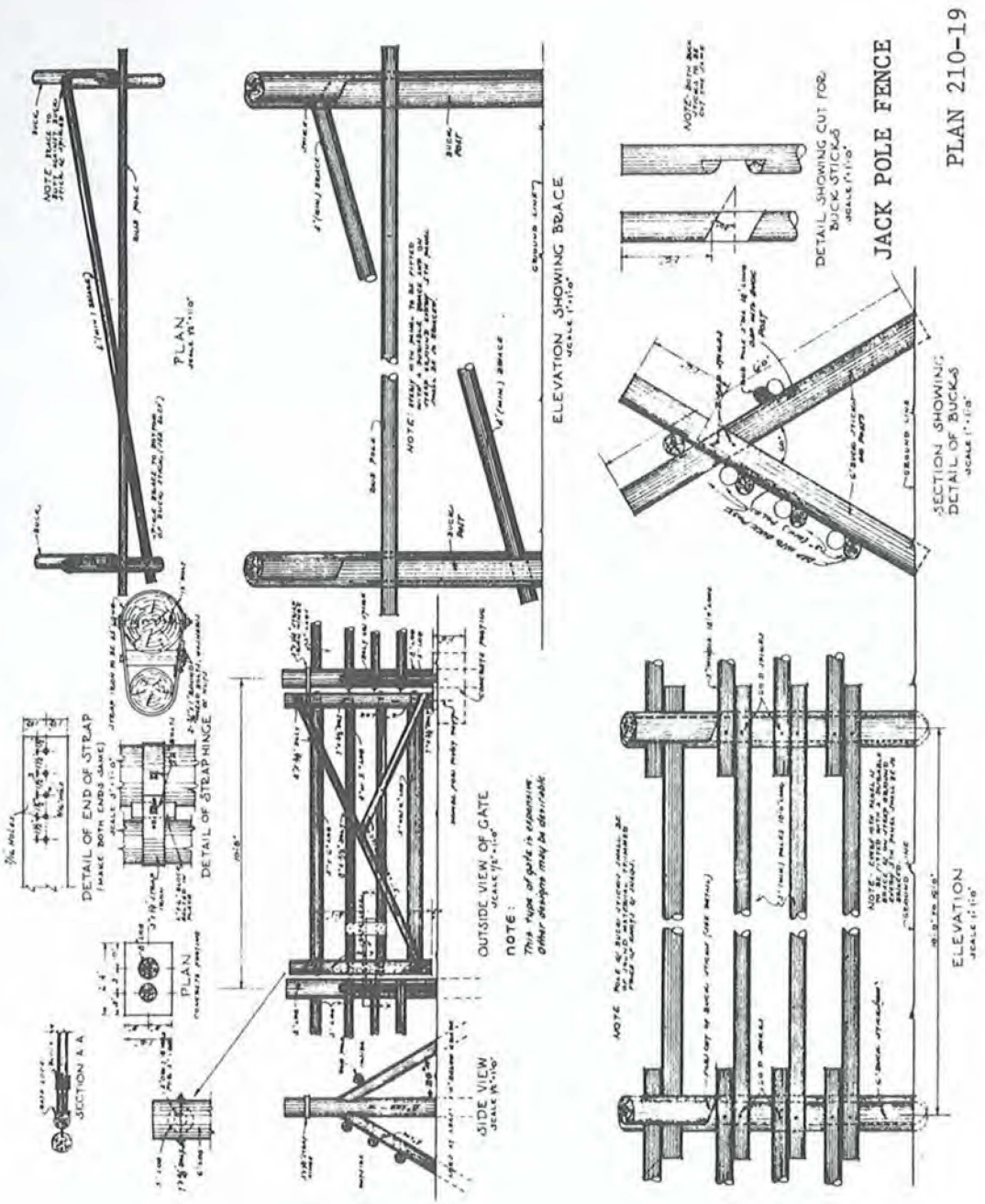


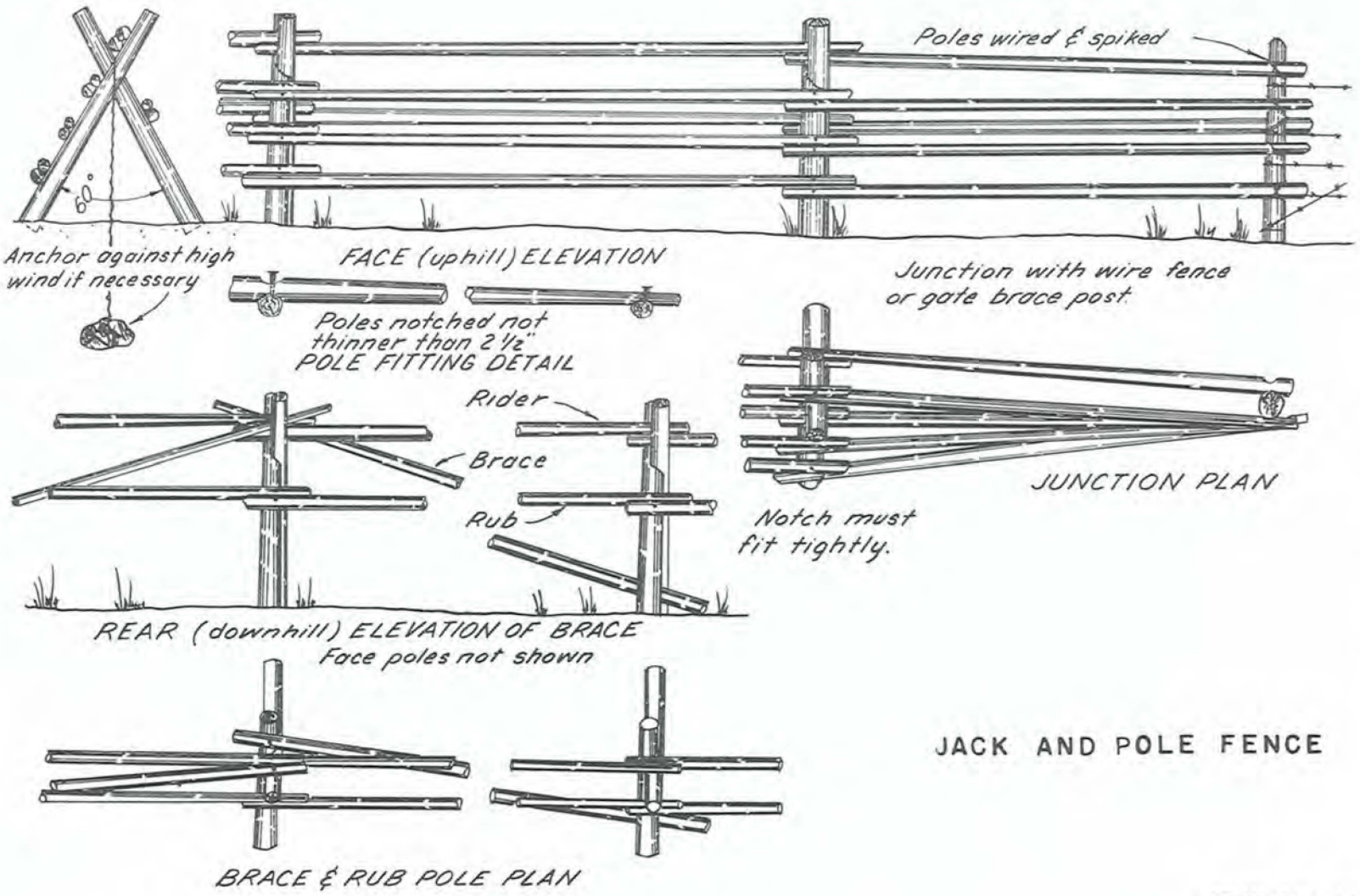

FIGURE C

Method of anchoring Jack leg wire fence by digging one hole instead of two - three posts are anchored instead of one.



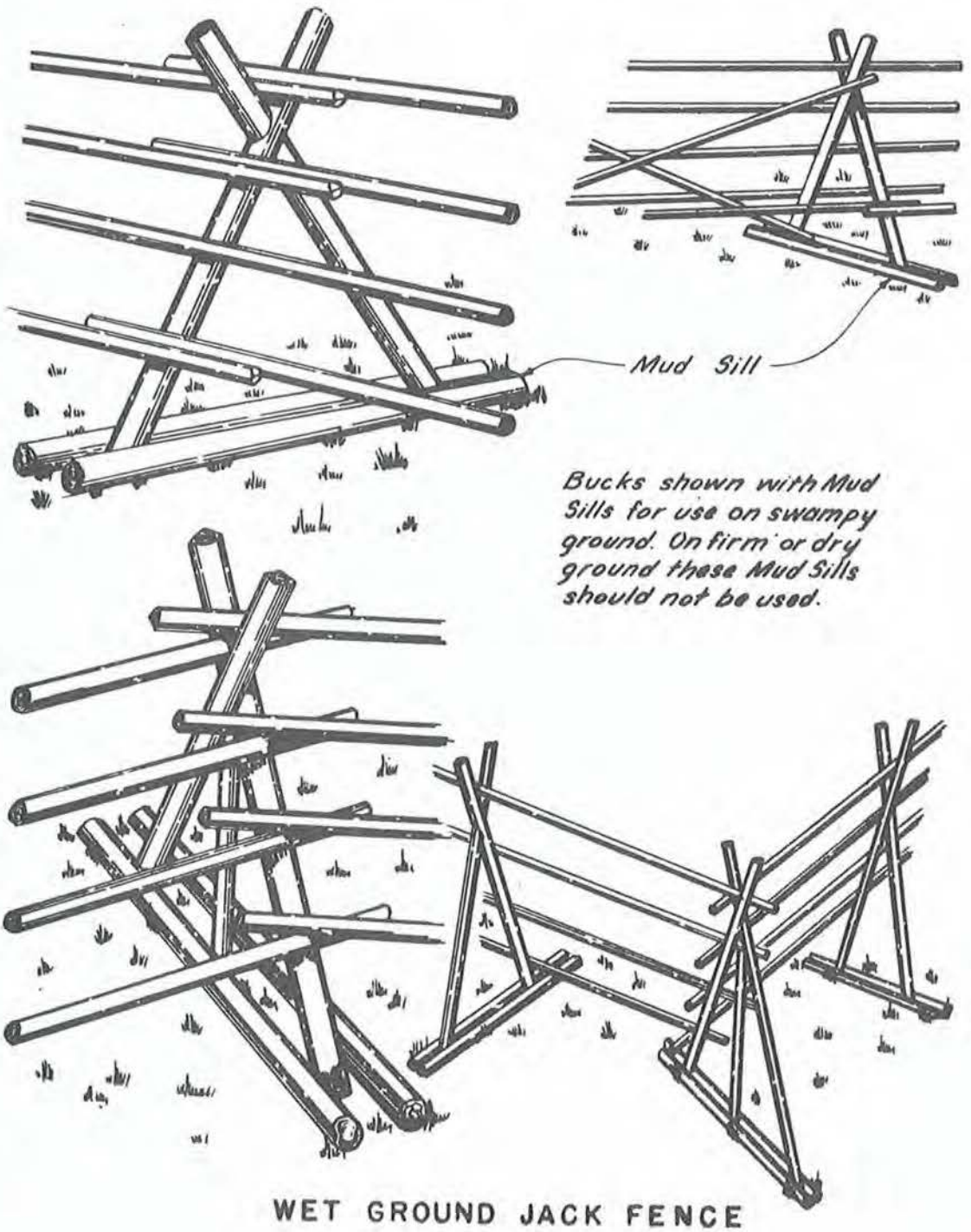

PLAN 210-18


JACK POLE FENCE
PLAN 210-19
PLAN
ELEVATION SHOWING BRACE
DETAIL OF END OF STRAP
DETAIL OF STRAP HINGE
OUTSIDE VIEW OF GATE
NOTE:
SIDE VIEW
SECTION A-A
DETAIL SHOWING CUT FOR BUCK STICKS
SECTION SHOWING DETAIL OF BUCKS
ELEVATION



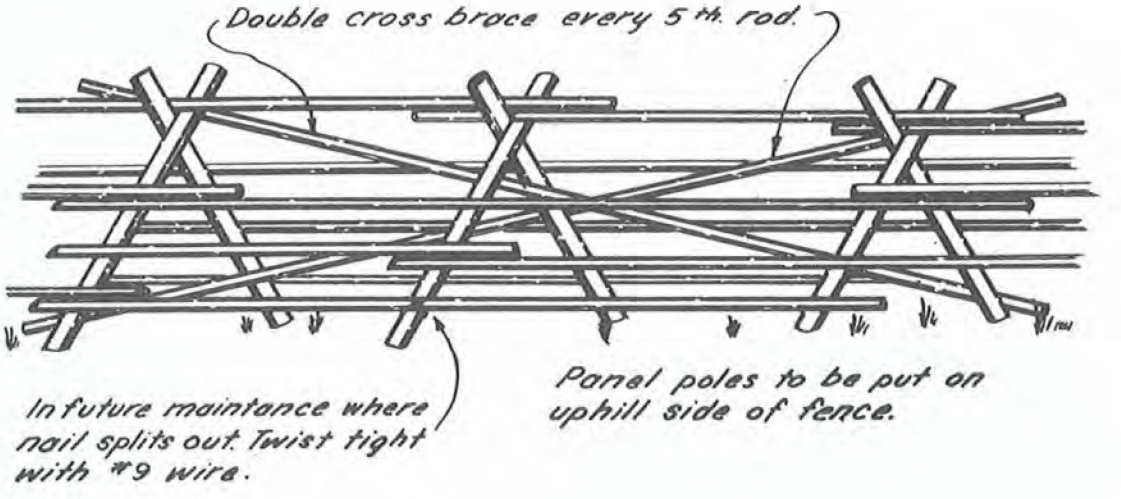

JACK AND POLE FENCE

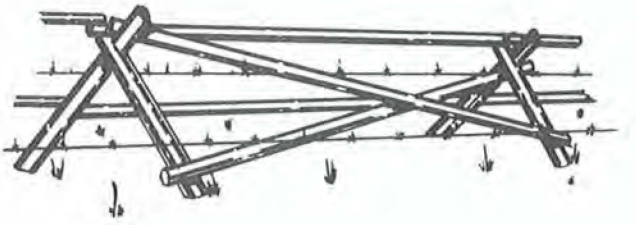
PLAN 210-20




WET GROUND JACK FENCE

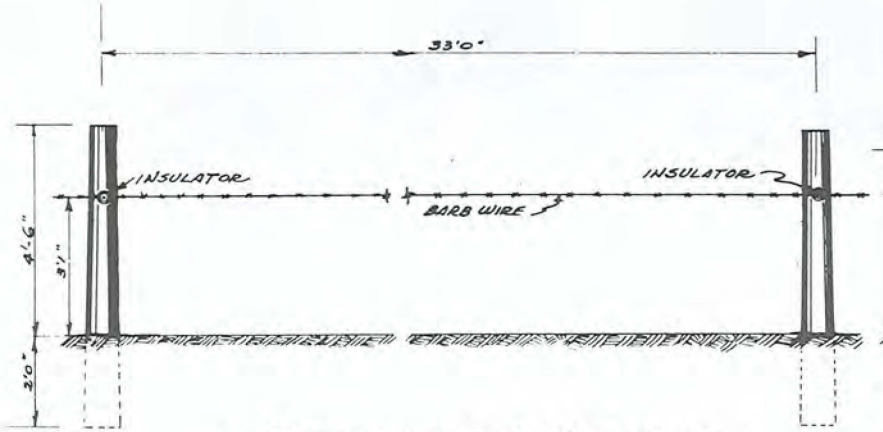
PLAN 210-21


Double cross brace every 5th rod.
In future maintance where nail splits out. Twist tight with #9 wire.
Panel poles to be put on uphill side of fence.

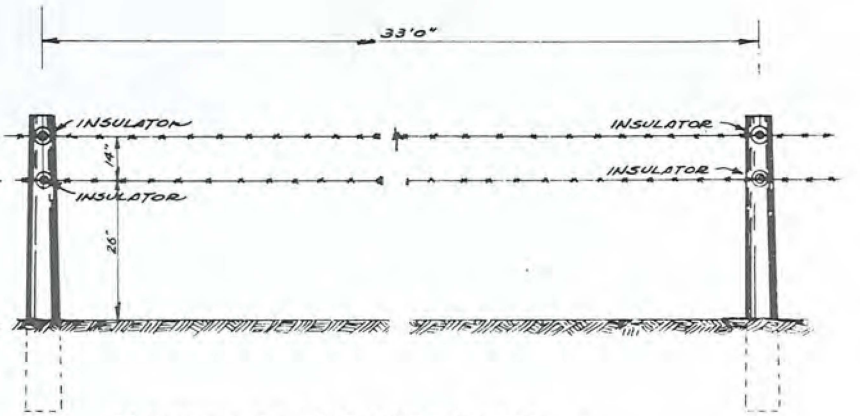


# POLE BRACING FOR JACK FENCES

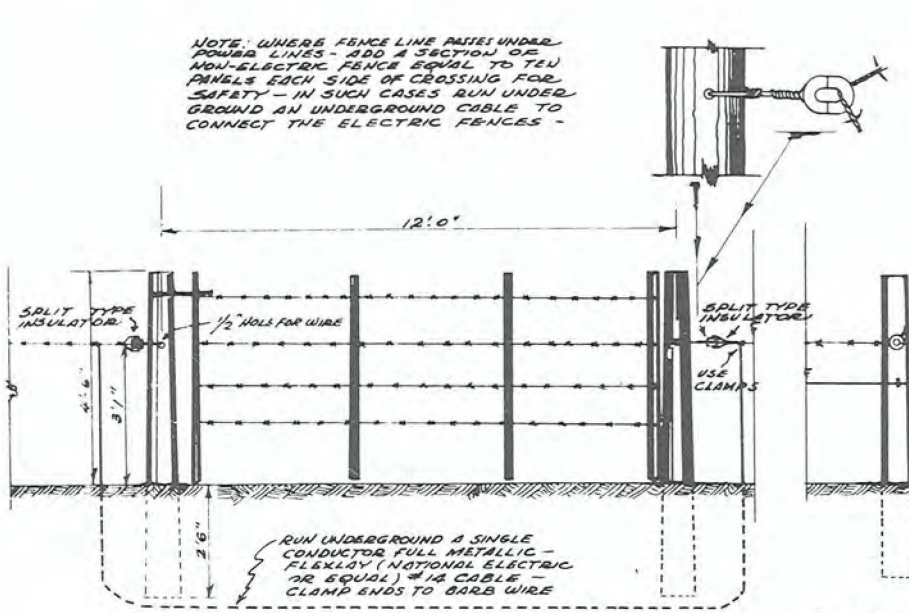
PLAN 210-22



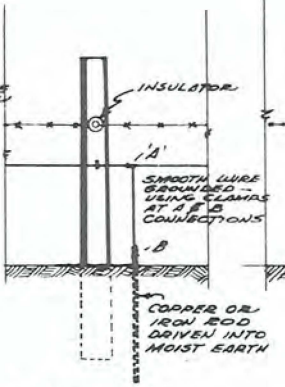

- SECTION OF ONE WIRE FENCE -



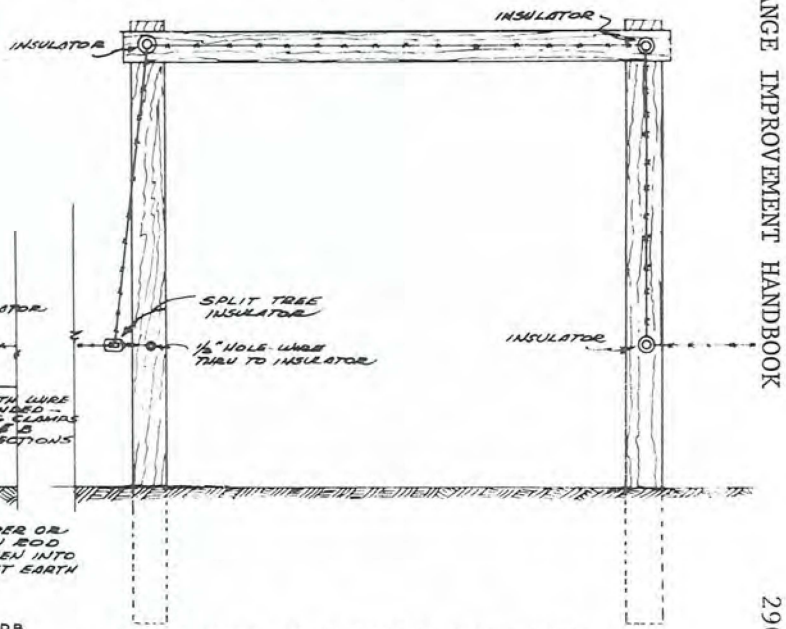

- SECTION OF TWO WIRE FENCE -


NOTE: WHERE FENCE LINE PASSES UNDER POWER LINES - ADD A SECTION OF NON-ELECTRIC FENCE EQUAL TO TEN PANELS EACH SIDE OF CROSSING FOR SAFETY - IN SUCH CASES RUN UNDER GROUND AN UNDERGROUND CABLE TO CONNECT THE ELECTRIC FENCES -
12'0"
SPLIT TYPE INSULATOR
½" HOLE FOR WIRE
SPLIT TYPE INSULATOR
USE CLAMPS
4'-6"
3'-1"
2'-6"
RUN UNDERGROUND A SINGLE CONDUCTOR FULL METALLIC - FLEXLAY (NATIONAL ELECTRIC OR EQUAL) #14 CABLE - CLAMP ENDS TO BARB WIRE

GATE WITH HOT WIRE UNDERGROUND -



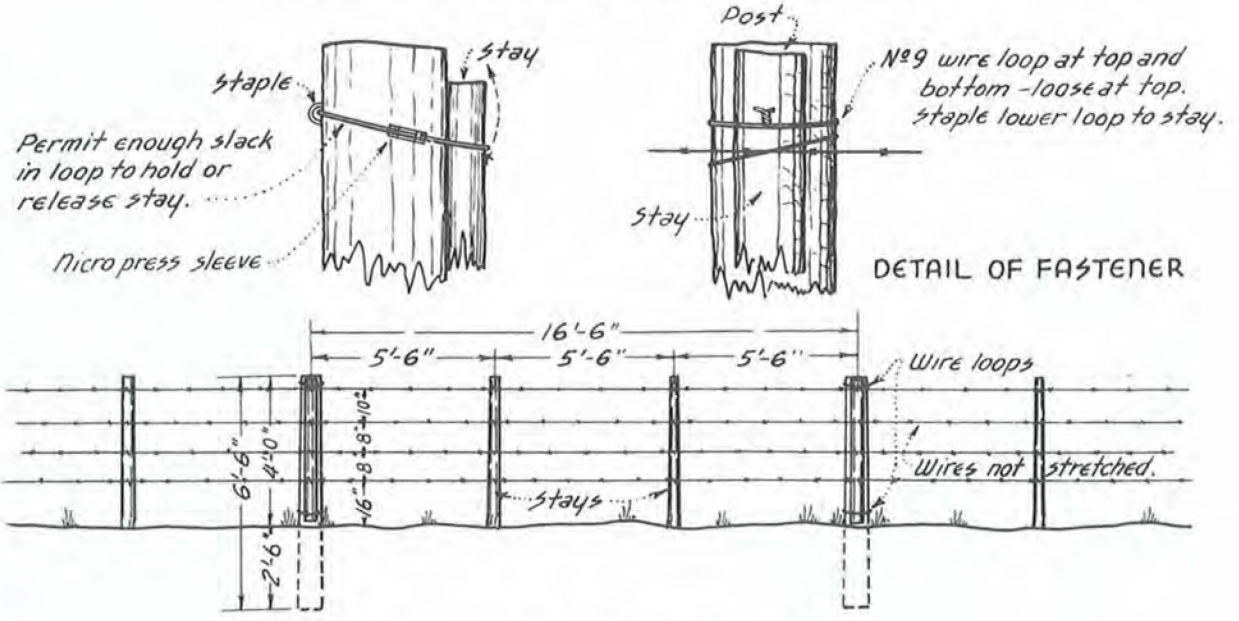

FENCE WITH BARB AND GROUND WIRE WITH GROUND ROD



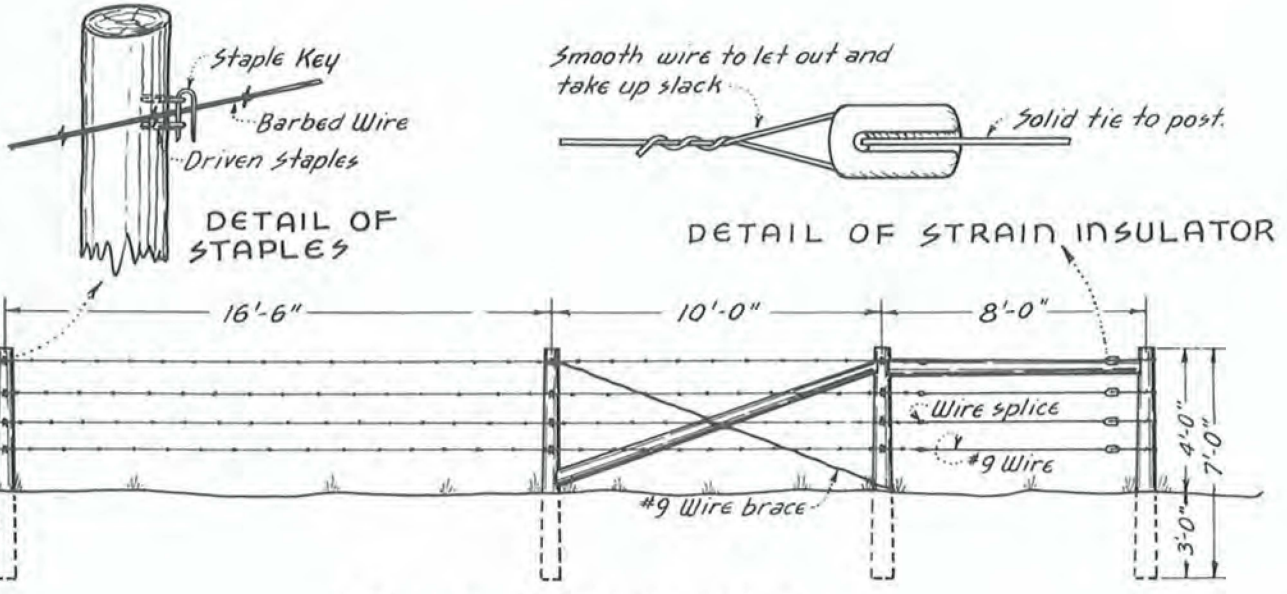

- GATE WITH HOT WIRE OVERHEAD -

ELECTRIC FENCES

PLAN 210-23




STAY LET-DOWN FENCE



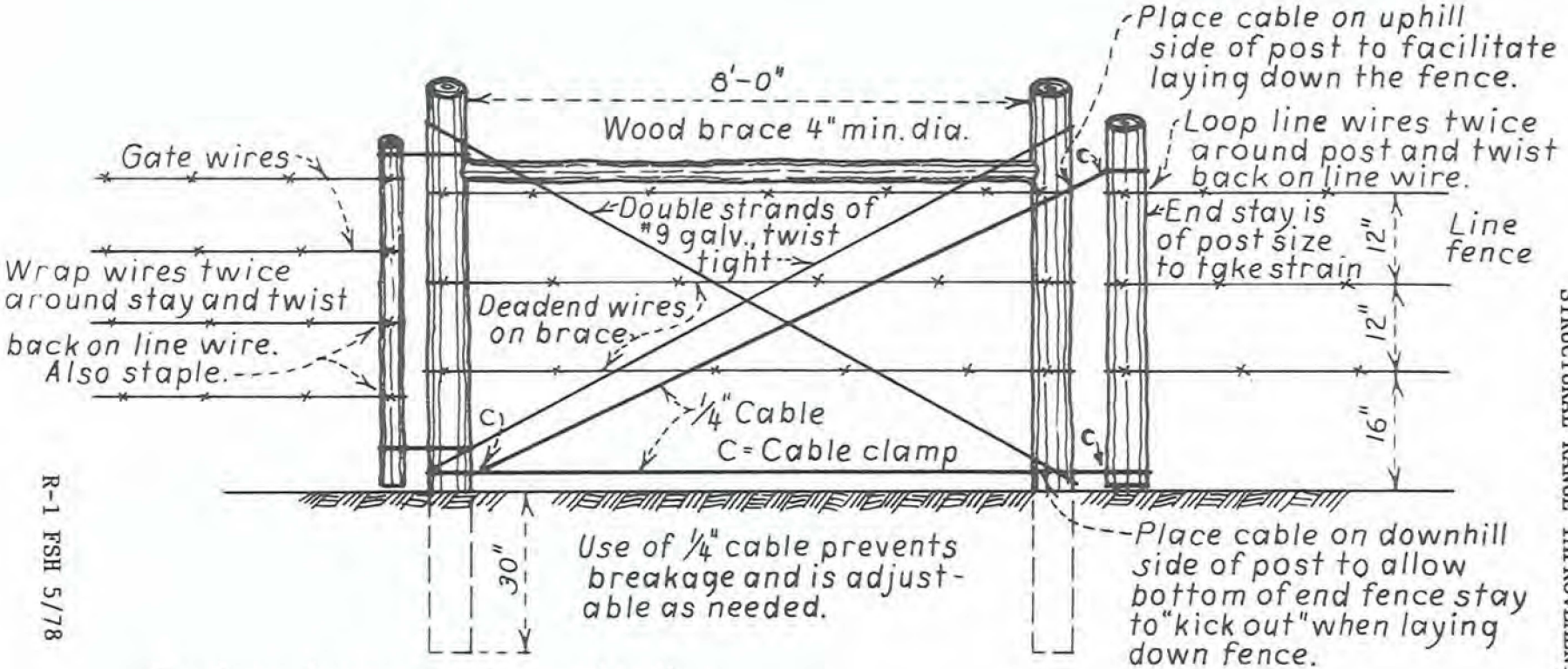

STAPLE LET-DOWN FENCE

# LET-DOWN FENCES

PLAN 210-24

NOTE

Steel posts may be used.


Place cable on uphill side of post to facilitate laying down the fence.
8'-0"
Wood brace 4" min. dia.
Loop line wires twice around post and twist back on line wire.
Gate wires
Double strands of #9 galv., twist tight
End stay is of post size to take strain
12"
12"
16"
Line fence
Wrap wires twice around stay and twist back on line wire. Also staple.
Deadend wires on brace
1/4" Cable
C = Cable clamp
C1
C
C
30"
Use of 1/4" cable prevents breakage and is adjustable as needed.
Place cable on downhill side of post to allow bottom of end fence stay to "kick out" when laying down fence.

Deadman brace may be used in lieu of deep set post. When used, deadman wire should end in back of post. Guy wire and 1/4" cable hook into this loop, and are not wrapped around post.

**BRACING LET-DOWN FENCE**

PLAN 210-25

R-1 FSH 5/78

## WOVEN WIRE for SHEEP ONLY




Note: In deep snow country one or two wooden stays may prevent snow damage. Posts may be spaced up to 25' apart depending on snow and other local conditions.

## WOVEN WIRE for SHEEP & CATTLE

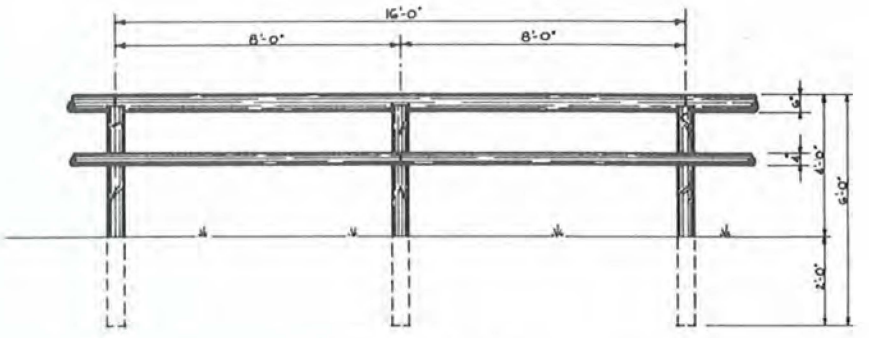



Note: In antelope country leave 14" space between top two wires.

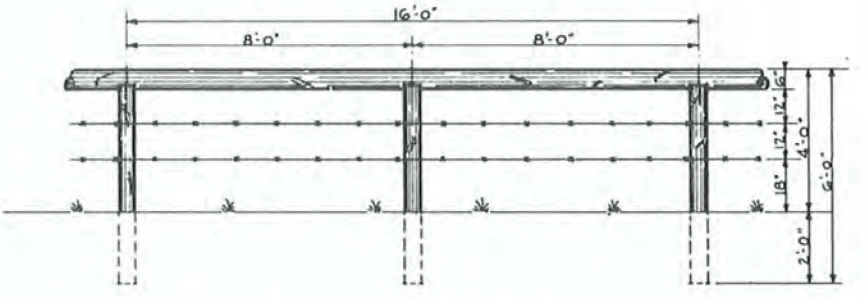
Note: One barbed wire strand may be spaced 2" above woven wire to prevent livestock damage to the woven wire.

**WOVEN WIRE FENCE**

PLAN 210-26



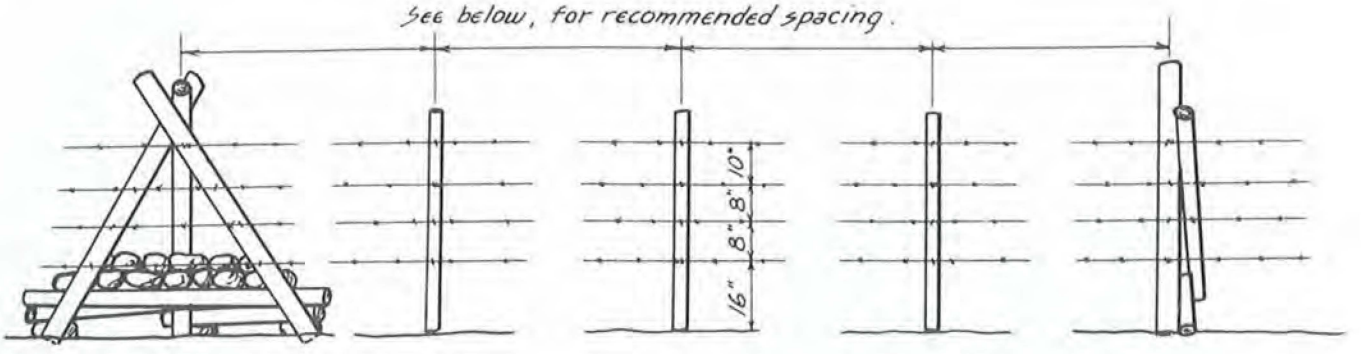

POST & POLE



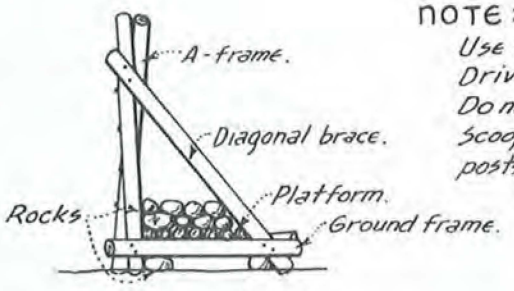

POST, POLE & WIRE

## POST & POLE FENCES

PLAN 210-27

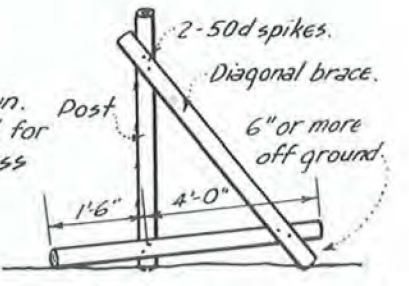



JACK STAY FIGURE FOUR



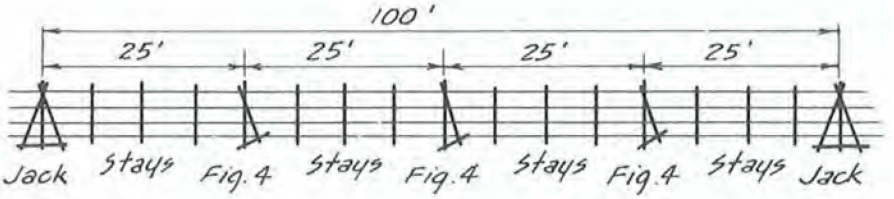

SIDE VIEW OF JACK

NOTE:
Use 2-50d nails at each joint.
Drive nails at binding angle.
Do not nail rock platform down.
Scoop shallow holes in ground, for posts & braces, to prevent excess slipping on hillsides.

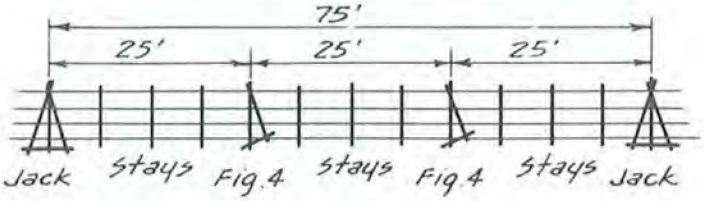



SIDE VIEW OF FIGURE FOUR

For level topography, light snowfall.

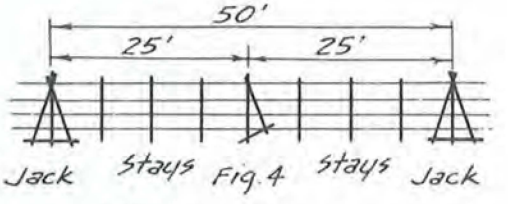



For moderately steep topography, moderate snowfall.




NOTE:
Place additional jacks at all abrupt breaks in topography.

For steep topography, heavy snowfall.

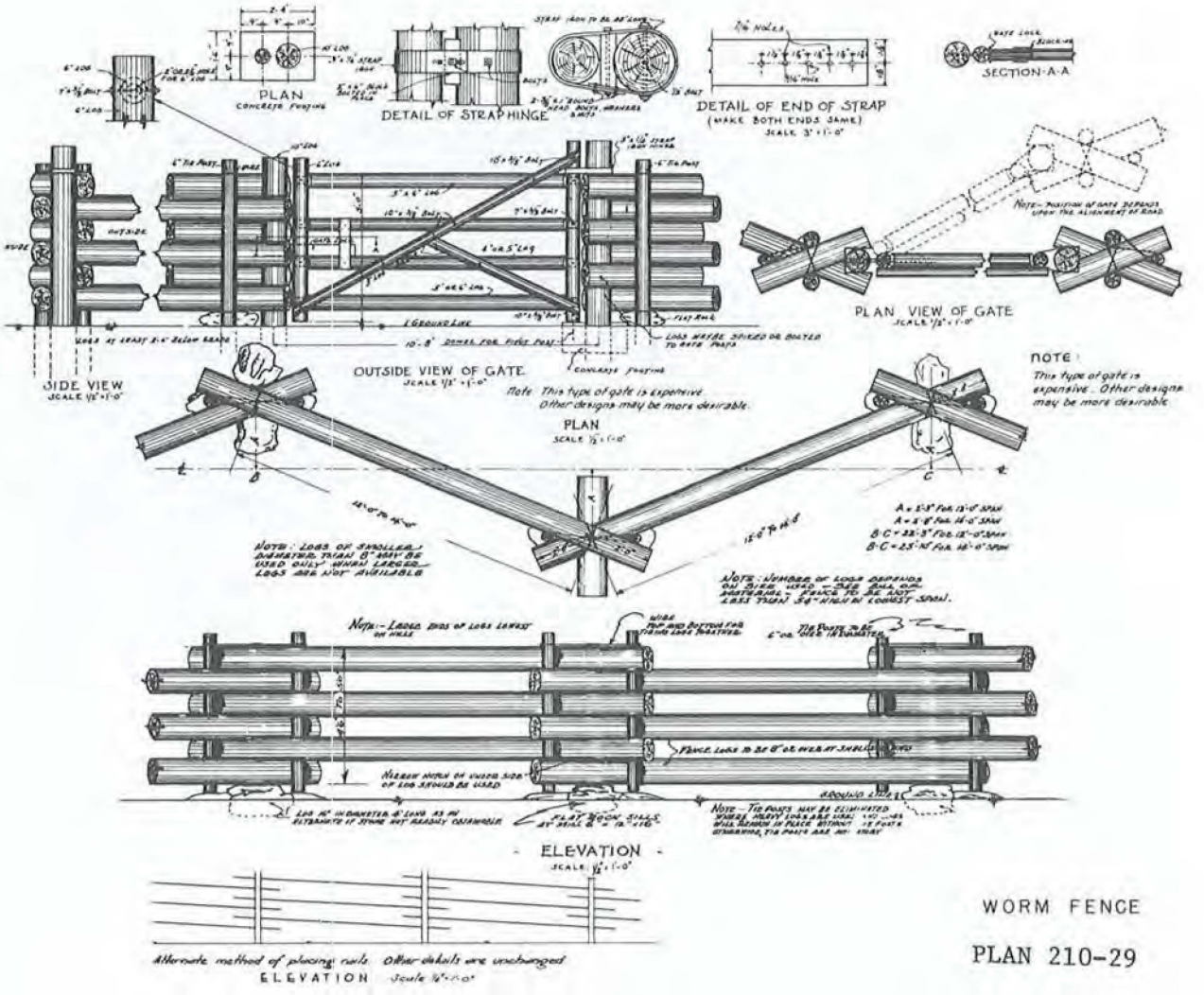



SPACING DIAGRAMS

# ROCK JACK AND FIGURE "4" FENCE

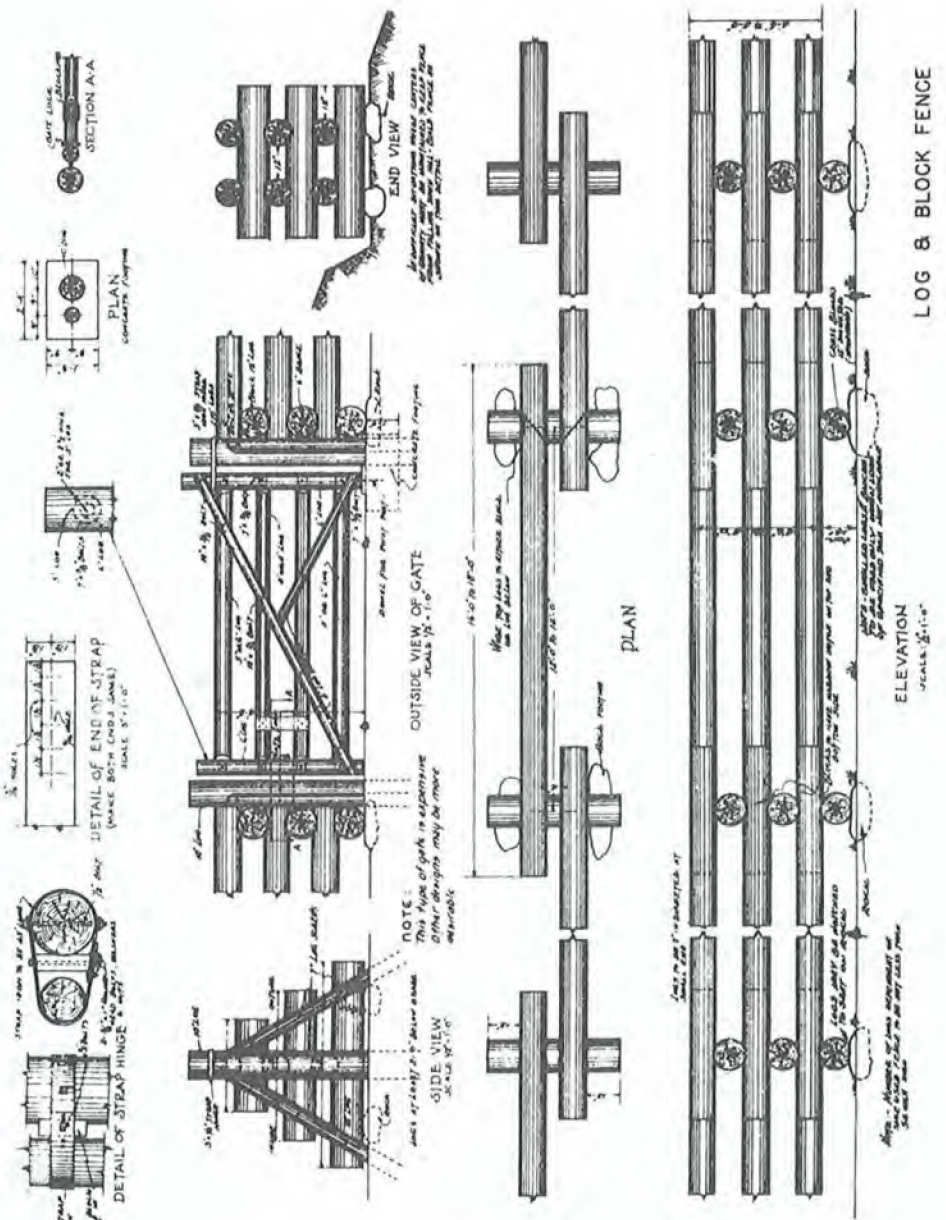
PLAN 210-28

# STRUCTURAL RANGE IMPROVEMENT HANDBOOK



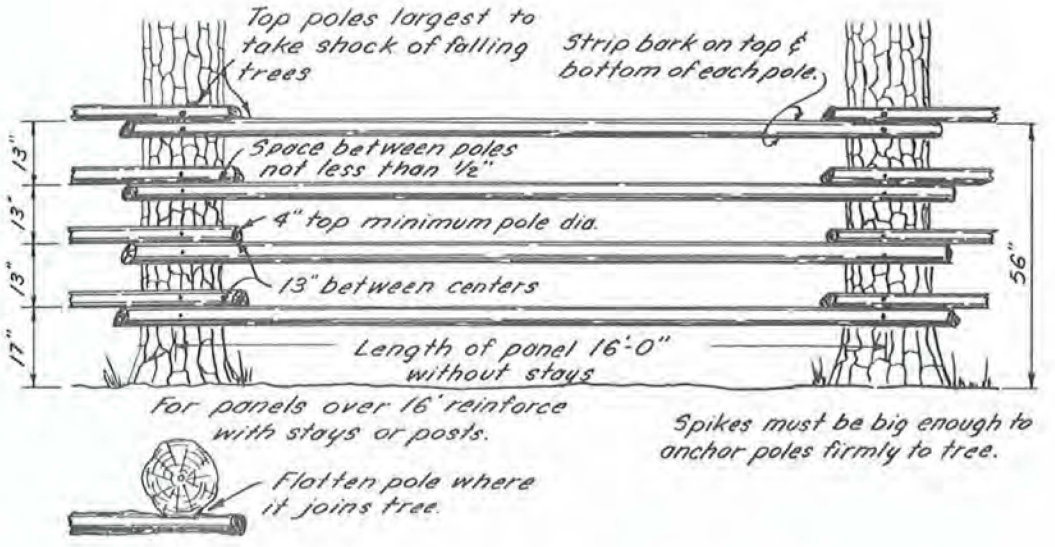

WORM FENCE

PLAN 210-29


DETAIL OF STRAP HINGE
DETAIL OF END OF STRAP
SECTION A-A
PLAN
END VIEW
OUTSIDE VIEW OF GATE
NOTE:
SIDE VIEW
PLAN
ELEVATION
LOG & BLOCK FENCE
PLAN 210-30

## POLES ON TREES

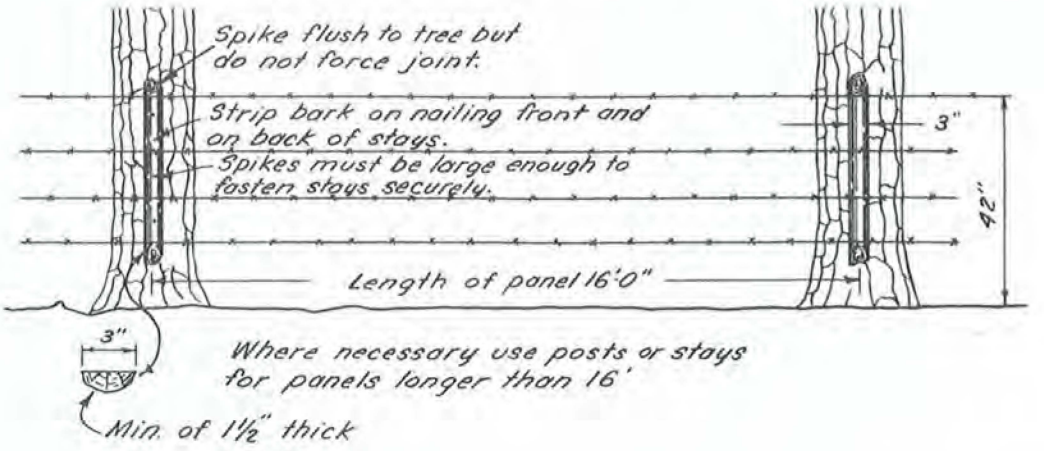
*A cheaper but efficient fence where poles are available.*


Top poles largest to take shock of falling trees
Strip bark on top & bottom of each pole.
Space between poles not less than ½"
4" top minimum pole dia.
13" between centers
Length of panel 16'-0" without stays
13"
13"
13"
17"
56"
For panels over 16' reinforce with stays or posts.
Spikes must be big enough to anchor poles firmly to tree.
Flatten pole where it joins tree.

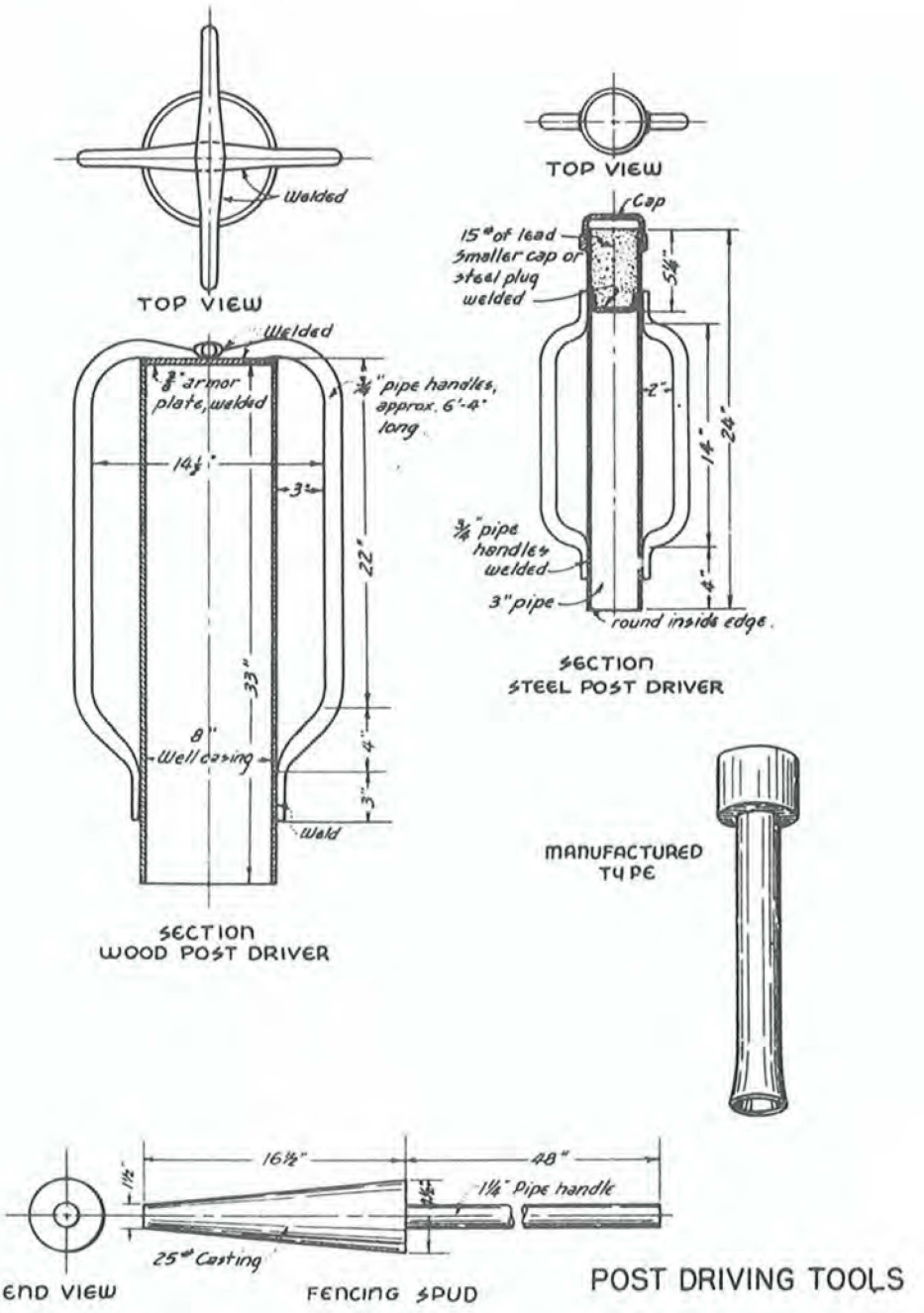
Do not clear right of way. Weave poles through trees on approximate line. Take poles from fence line where possible.

## WIRE ON TREES

*Permissible where probability of wind fall damage to wire is reasonably light. Most adaptable to timber park areas.*

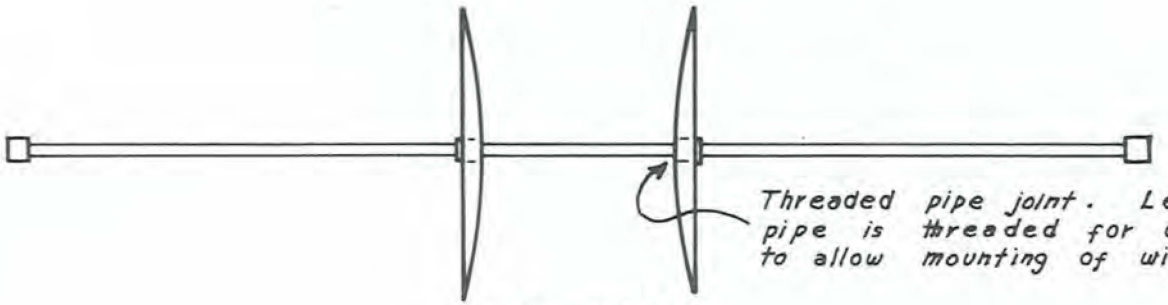

Spike flush to tree but do not force joint.
Strip bark on nailing front and on back of stays.
Spikes must be large enough to fasten stays securely.
3"
42"
Length of panel 16'0"
3"
Where necessary use posts or stays for panels longer than 16'
Min. of 1½" thick

PLAN 210-31




POST DRIVING TOOLS

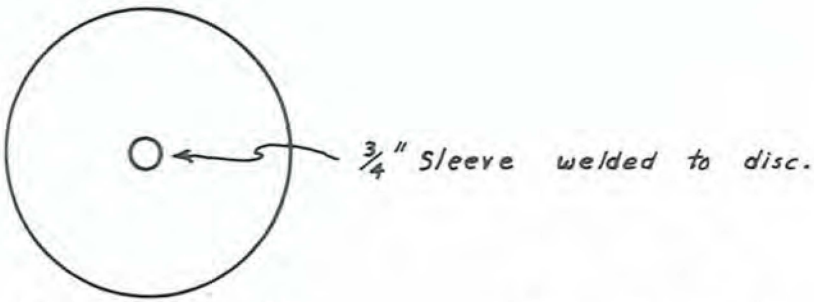
PLAN 210-32




END VIEW

BILL OF MATERIALS

| | |
|---|---|
| 2 | 3/4" x 2½' Pipe |
| 2 | 3/4" Caps |
| 2 | 3/4" Sleeves |
| 1 | 3/4" x 1' Pipe |
| 2 | 18" Grain drill disc |



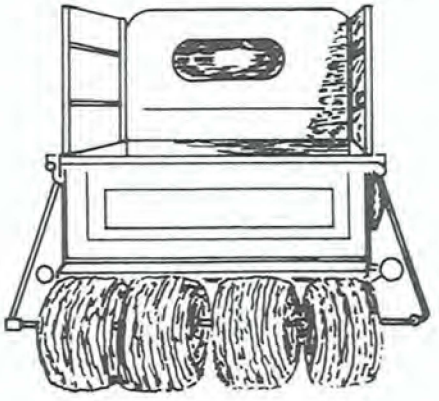

SIDE VIEW

Scale 1" = 1'-0"
Nov. 8, 1962
by Stephen M. Rushton

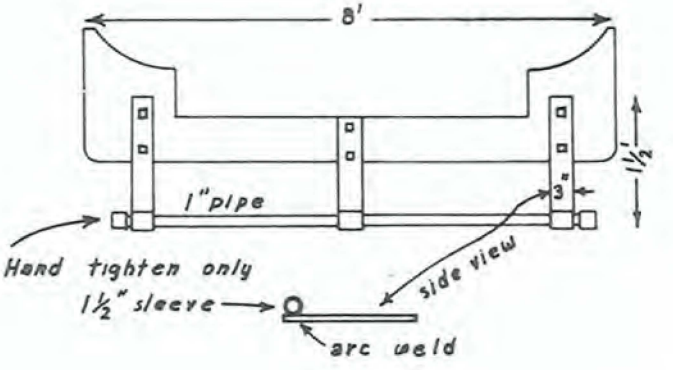
**TWO MAN WIRE STRINGER**

PLAN 210-33

The three 1½" pipe sleeves are welded to the ends of the three pieces of steele ½" x 3" x 18", which in turn are bolted to the rear bumper of the vehicle. The 1" pipe should be threaded on both ends and the 1" sleeves should be used to keep it from slipping through the 1½" sleeves while the wire is unrolling. Six metal discs discarded from a disc or seed drill should be used to keep the wire rolls turning separately. This device can be used successfully wherever a pickup or 4-wheel drive vehicle can be driven along the fence line.



WIRE STRINGER ATTACHMENT



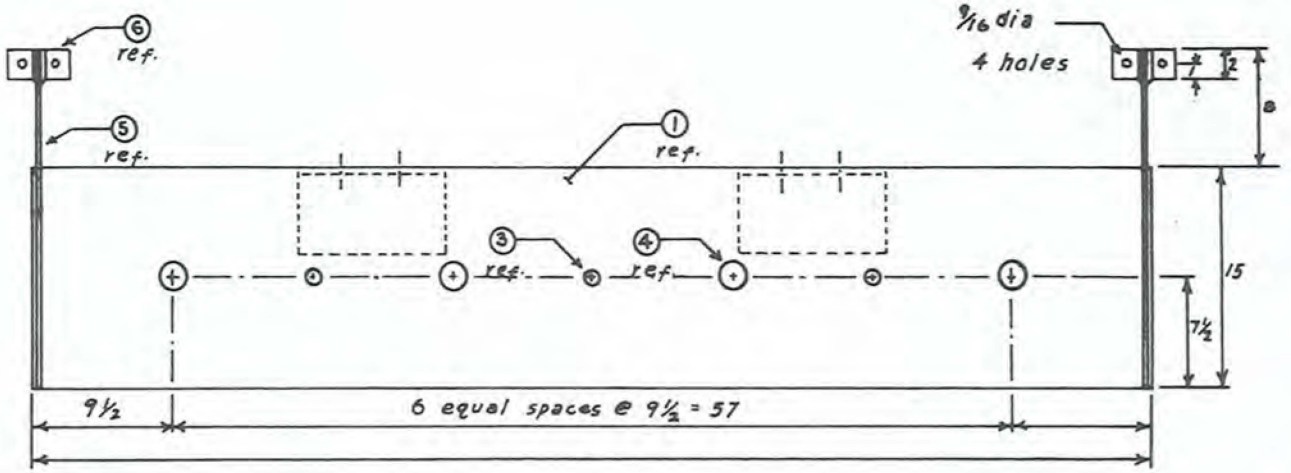

TOP VIEW

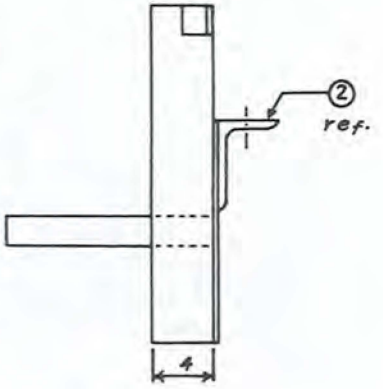
BILL of MATERIALS

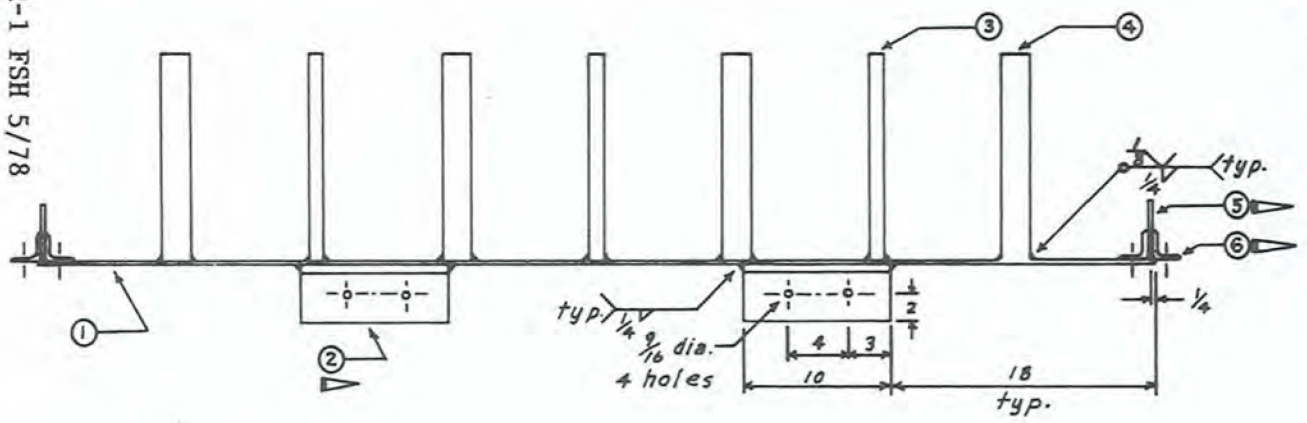
3 - ½" x 3" x 18" plate steel
3 - 1½" pipe sleeves
2 - 1" pipe sleeves
1 - 7' length 1" pipe
6 - ½" x 3" machine bolts

WIRE STRINGER

PLAN 210-34




NOTES

Items ② ⑤ & ⑥ may have to be revised depending on back bumper of truck.

| Qty | Item | Nomenclature or description | Mtrl. |
|---|---|---|---|
| 4 | 6 | Angle 2x2x ¼ | stl. |
| 2 | 5 | ¼ Plate | stl. |
| 4 | 4 | Pipe 1½ I.D. x 14 L.G. | stl. |
| 3 | 3 | Pipe ¾ I.D. x 14 L.G. | stl. |
| 2 | 2 | Angle 4 x 6 x ½ | stl. |
| 1 | 1 | ¼ Plate | stl. |

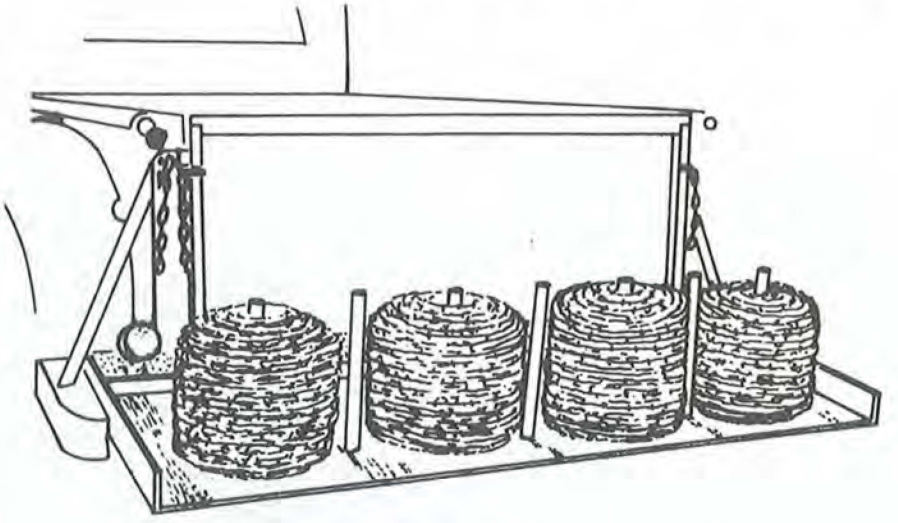
# BARBED WIRE STRINGER

PLAN 210-35

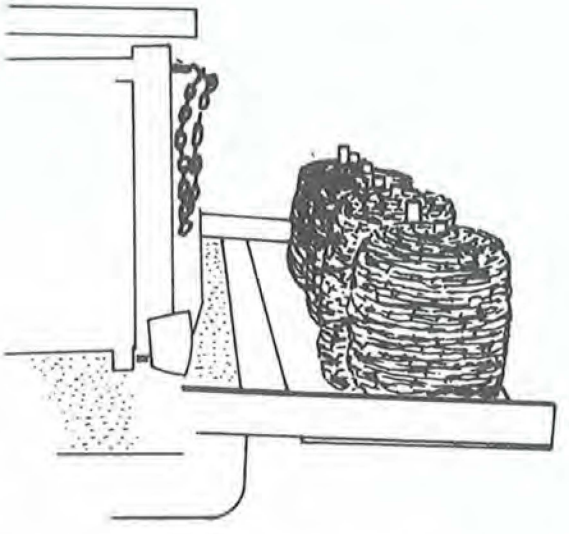
Sheet 1 of 2

R-1 FSH 5/78

290--35



*Rear view of barbwire stringer mounted on pickup truck.*



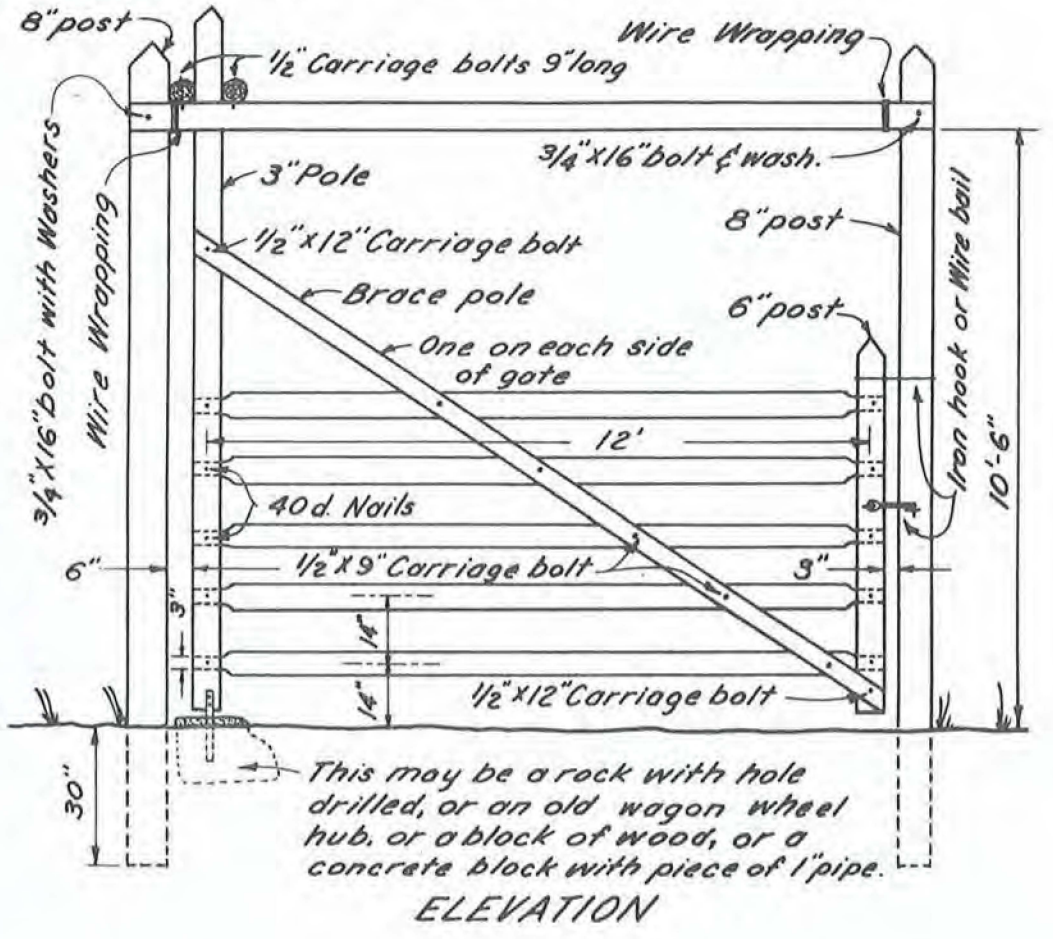
*Side view of barbwire stringer mounted on pickup truck.*

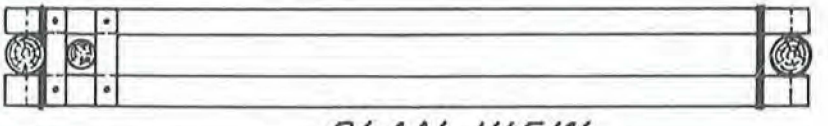
**BARBED WIRE STRINGER**

PLAN 210-35

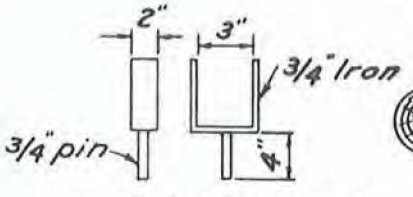
**Sheet 2 of 2**

# RANGE AND PASTURE POLE GATE



PLAN VIEW

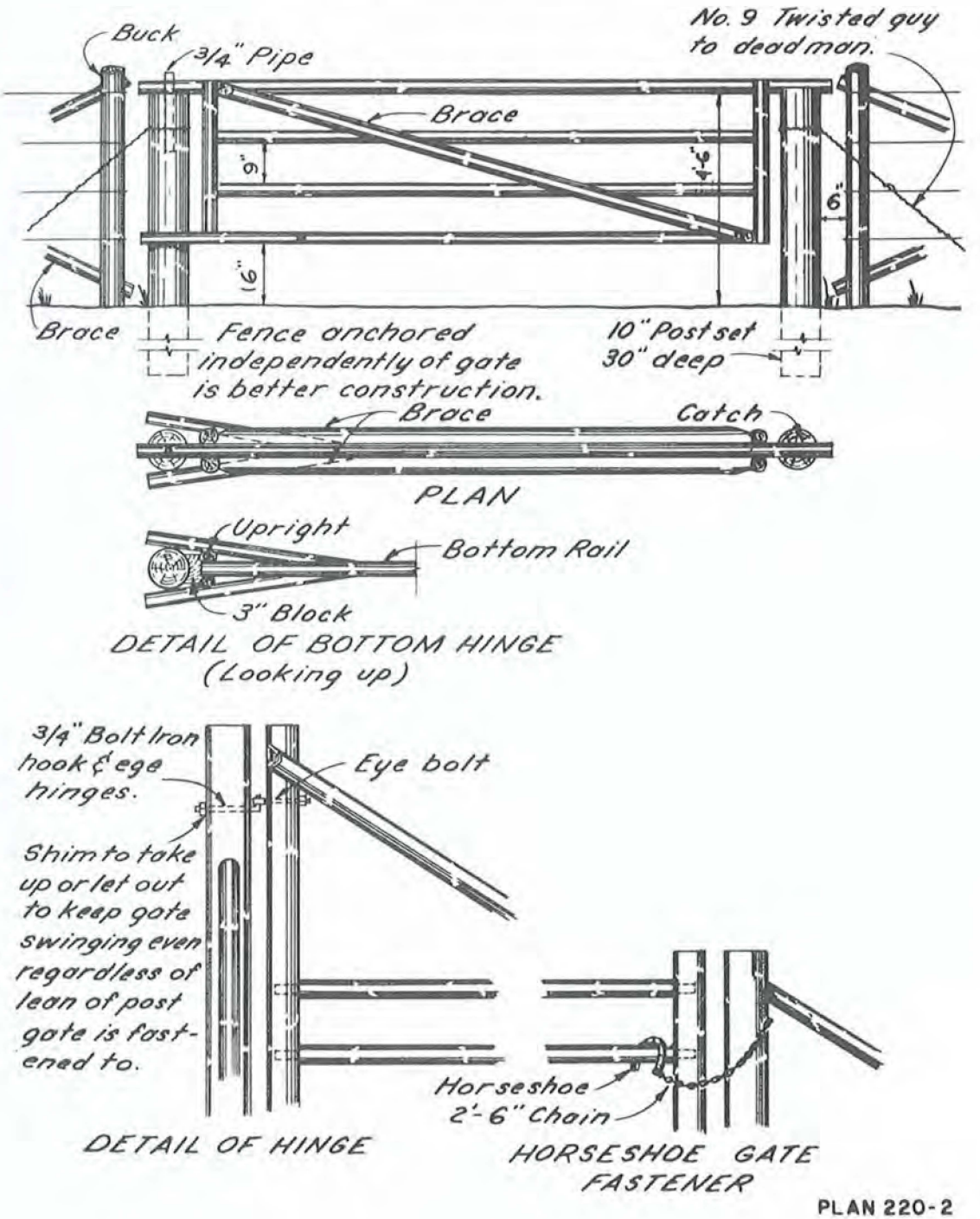



STIRRUP FOR GATE POST

If Stirrup is not used bore a "11/16" hole and drive in a 3/4"pin in pole.

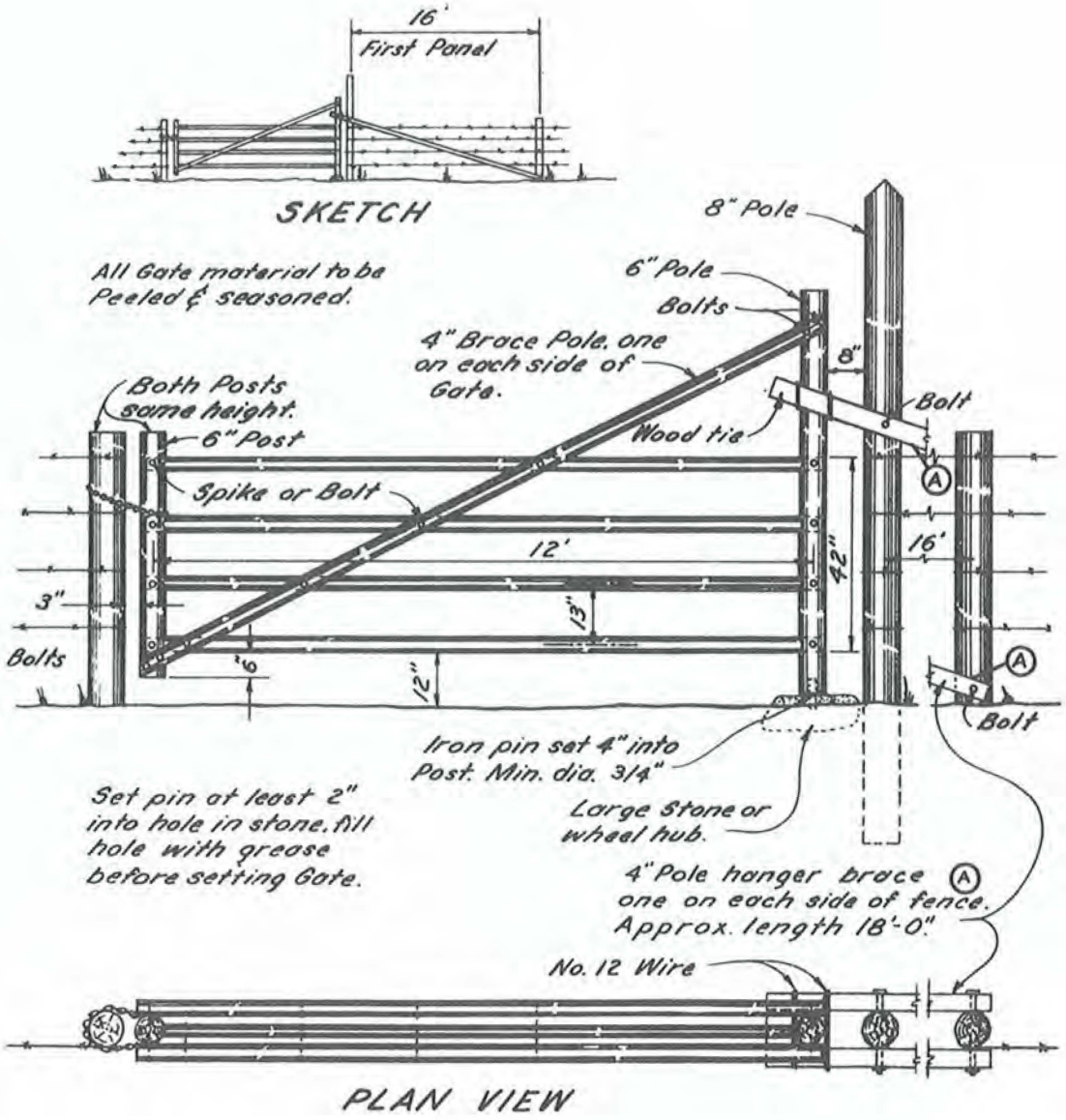
PLAN 220-1

# GATE CONSTRUCTION

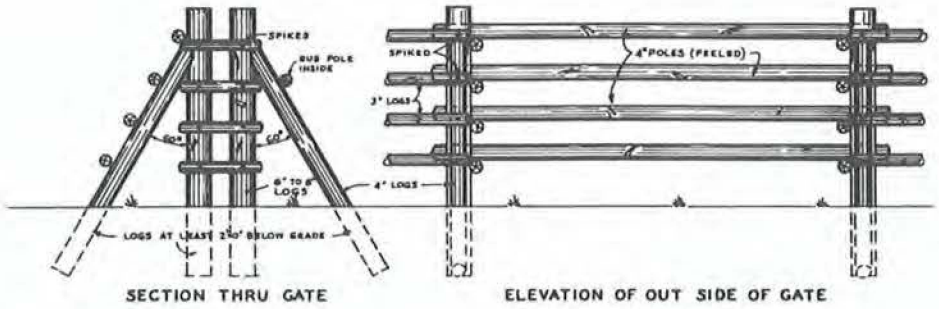



PLAN 220-2

# POLE GATE WITH PANEL ANCHOR



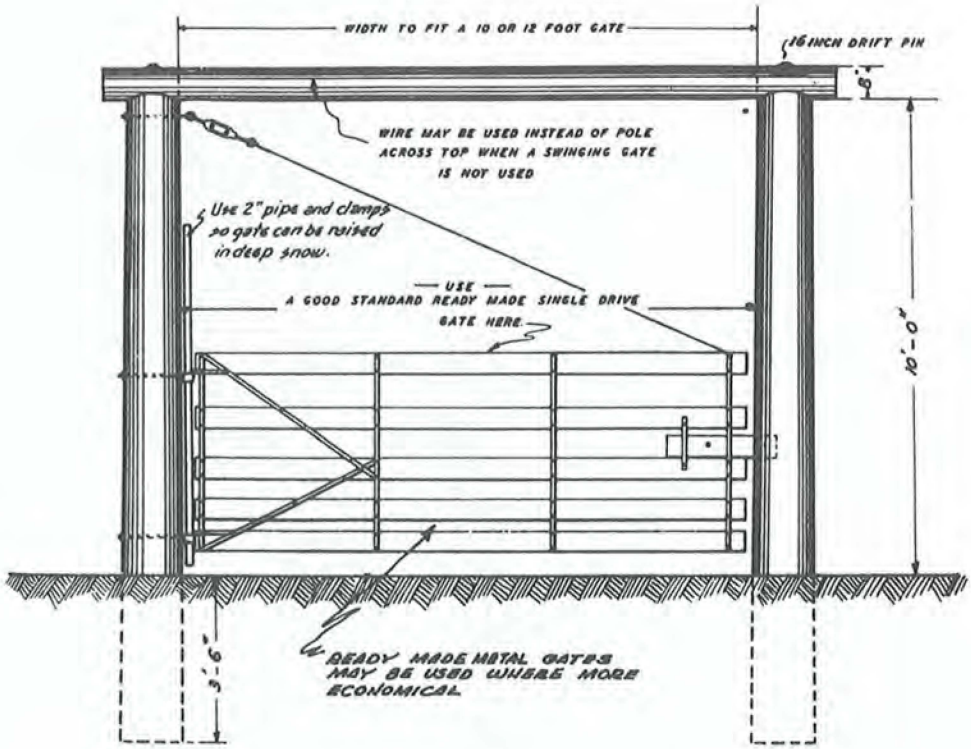

PLAN 220-3




NOTE: AN EXTRA STANDARD TO PROVIDE A 4-FOOT GAP AT ONE END WHEN BARS ARE ONLY PARTIALLY PUSHED BACK IS HANDY TO ALLOW PASSAGE OF SADDLE HORSE OR FOOT TRAFFIC. IN THIS CASE THE MAIN OPENING SHOULD BE AT LEAST 12 FEET AND THE BARS 18 FEET LONG.

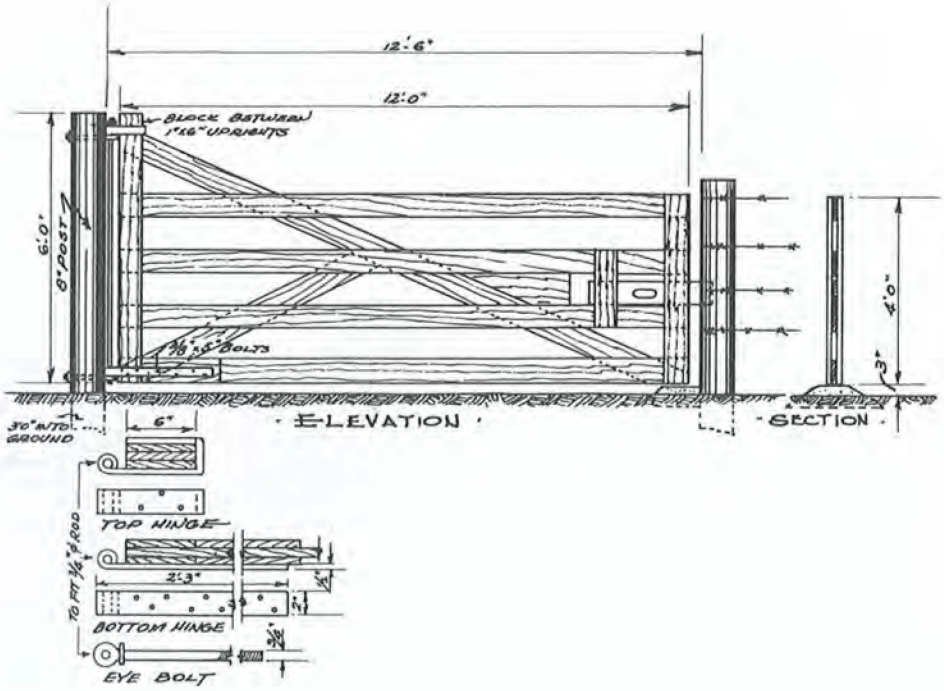
SLIDING POLE GATE

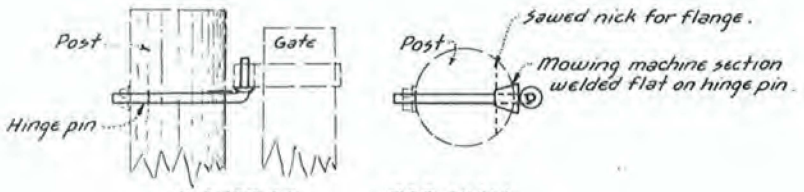
PLAN 220-4


WIDTH TO FIT A 10 OR 12 FOOT GATE
16 INCH DRIFT PIN
WIRE MAY BE USED INSTEAD OF POLE ACROSS TOP WHEN A SWINGING GATE IS NOT USED
Use 2" pipe and clamps so gate can be raised in deep snow.
USE A GOOD STANDARD READY MADE SINGLE DRIVE GATE HERE.
10'-0"
3'-6"
READY MADE METAL GATES MAY BE USED WHERE MORE ECONOMICAL

*FRAME AND BRACING FOR GATE OPENING ON FREQUENTLY USED ROADS WHERE LONG POSTS ARE AVAILABLE*

## FENCE GATE
## WITH OVERHEAD BRACING & SPECIAL HINGING
## PLAN 220-5



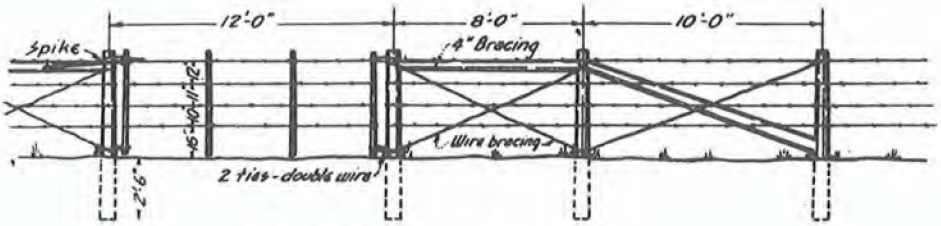




FLANGED HINGE PIN

*To prevent turning of pin when gate swings.*

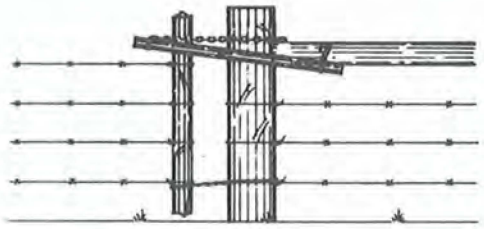
BOARD GATE

PLAN 220-6




WIRE GATE AND BRACING

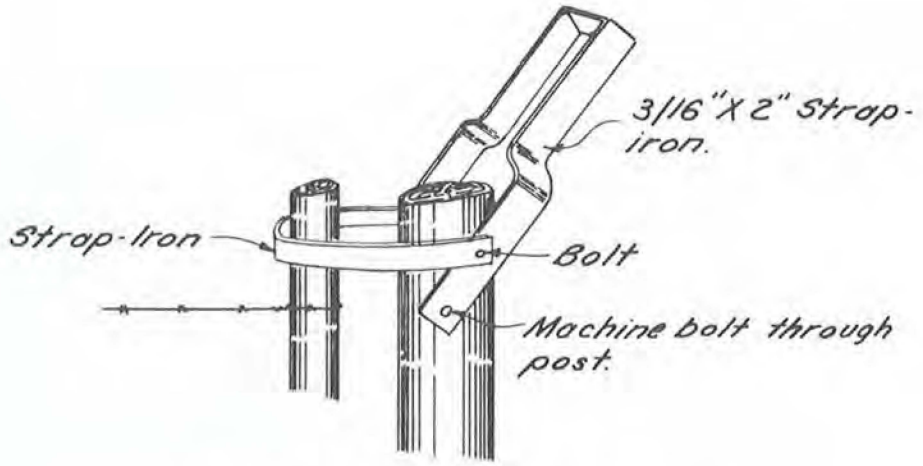
PLAN



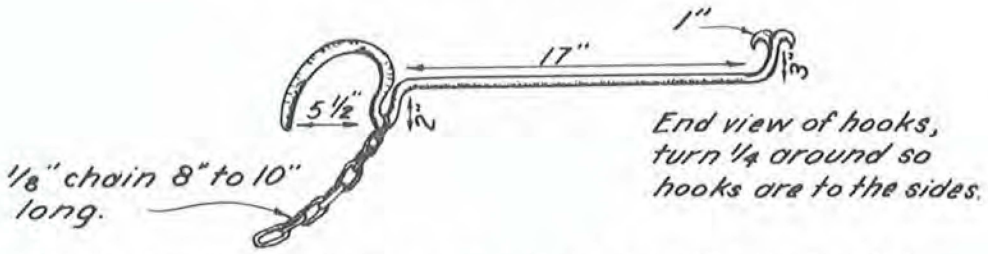
ELEVATION

WIRE GATE CLOSER

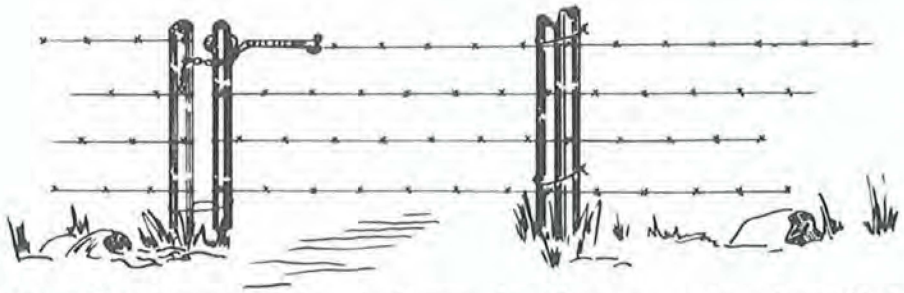
WIRE GATE
PLAN 220-7




## WIRE-GATE FASTENERS




Make large hook on one end of a half circle, 5½" to 6" on the inside, bend on down to an eye. run through link in end of chain, bend at a right angle, 90°; then straighten 17," bend up at 90° 3," flatten out 1" on end and split, bending one to each side, making two hooks to hook onto wire.

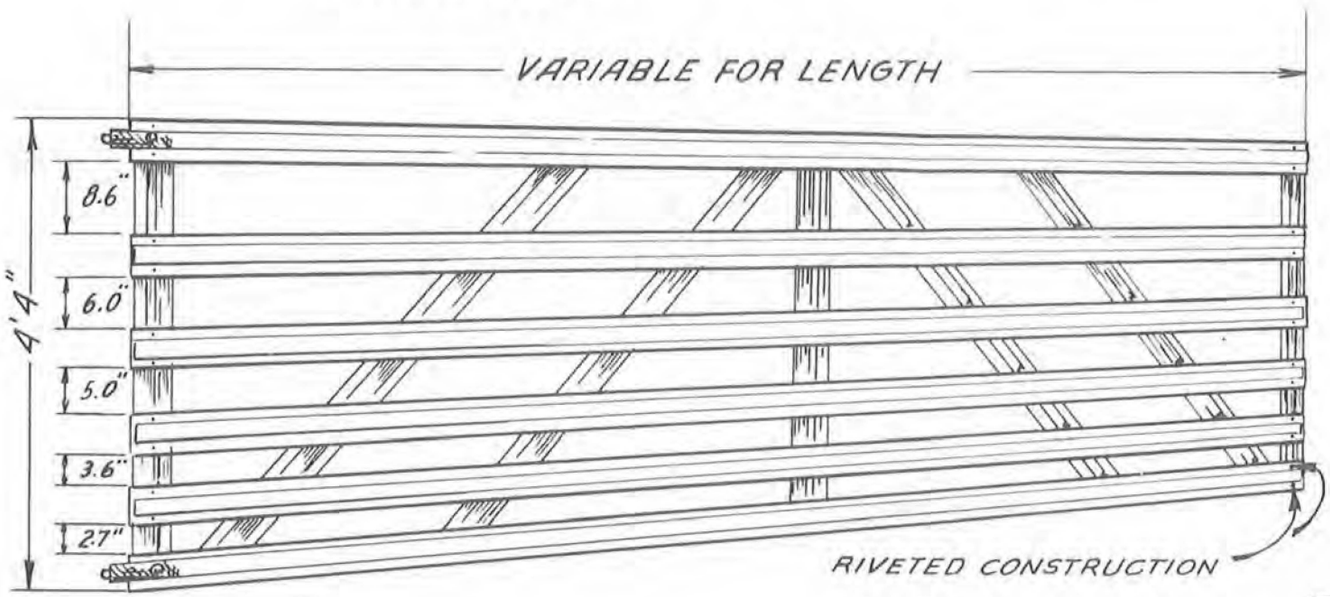


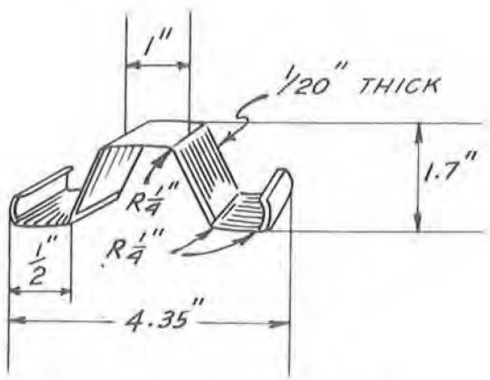
When closing gate, hook large hook around gate stick, bring other end toward gate and hook one of the small hooks to top wire.

PLAN 220-8

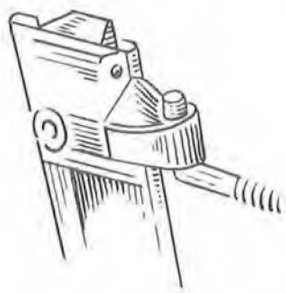
# TYPICAL ALUMINUM GATE

(COMPLETE WITH CAST ALUMINUM HINGES, SCREW-HOOKS, BOLTS & GATE LATCH)




DETAIL OF U-BEAM

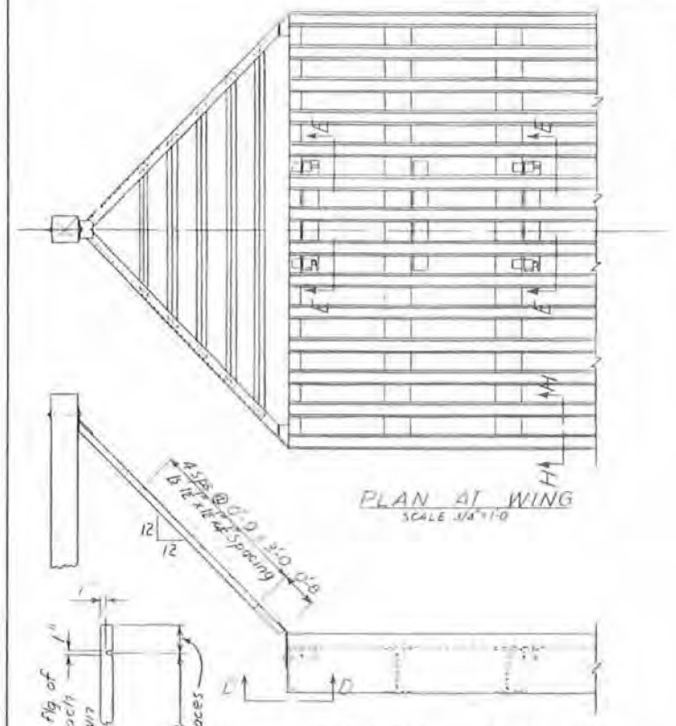


GATE HINGE

SIZES AVAILABLE

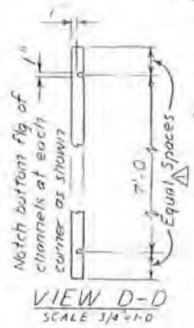
| OPENING LENGTH | HEIGHT | HORIZONTAL MEMBERS | SHIPPING WEIGHT | GAGE |
|---|---|---|---|---|
| 16' | 52" | 6 | 59 lbs | 18 |
| 14' | 52" | 6 | 54 lbs | 18 |
| 12' | 52" | 6 | 43 lbs | 18 |
| 10' | 52" | 6 | 39 lbs | 18 |
| 4' | 52" | 6 | 17 lbs | 18 |

PLAN 220-9

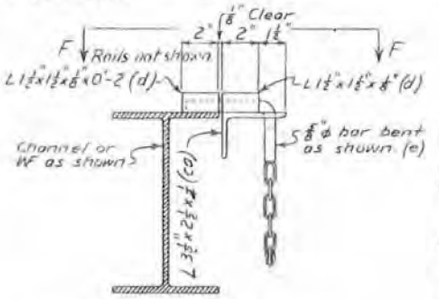



PLAN AT WING
SCALE 3/4"=1'-0

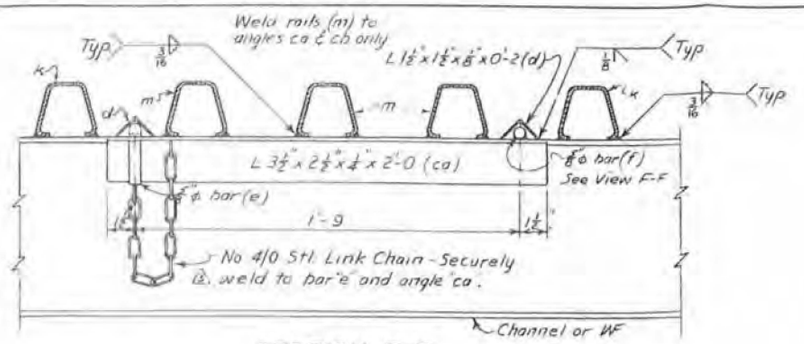
ELEVATION AT WING
SCALE 3/4"=1'-0



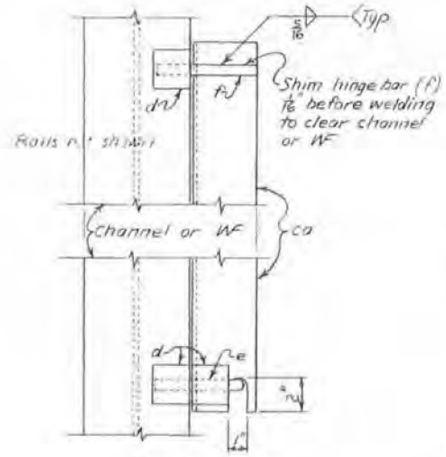

VIEW D-D
SCALE 3/4"=1'-0



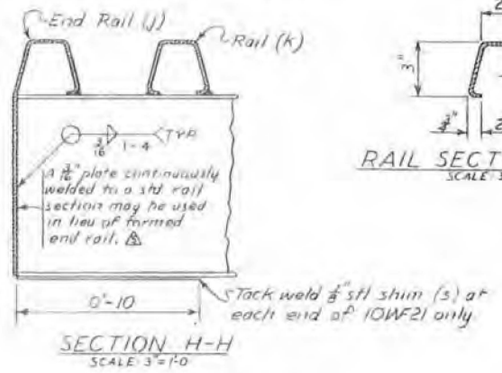

END VIEW-SECTION E-E
SCALE 3"=1'-0



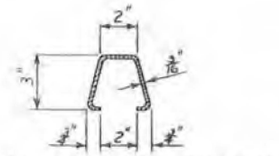

SECTION E-E
SCALE 3"=1'-0



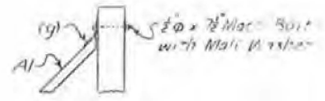

VIEW F-F
SCALE 3"=1'-0


End Rail (j)
Rail (k)
3/16
1-4 TYP
A ⅜" plate continuously welded to a std rail section may be used in lieu of formed end rail. ⚠
0'-10
Tack weld ⅜" stl shim (s) at each end of 10WF21 only

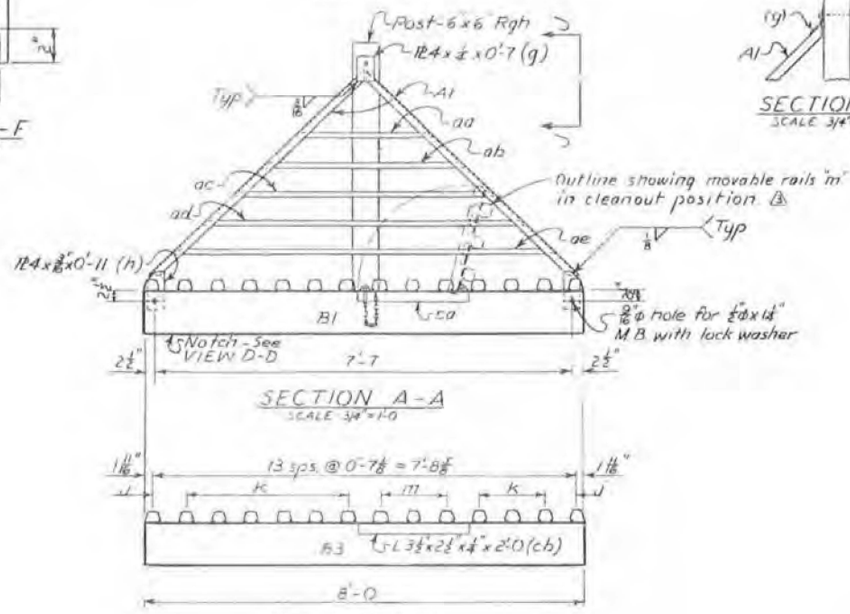
SECTION H-H
SCALE 3"=1'-0




RAIL SECTION DETAIL
SCALE 3"=1'-0



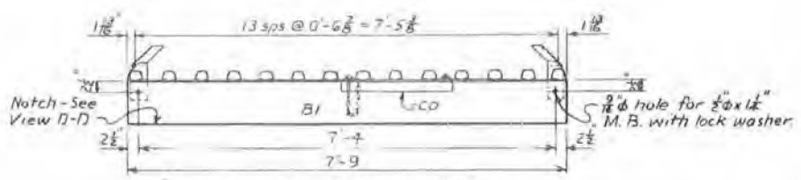

SECTION J-J
SCALE 3/4"=1'-0



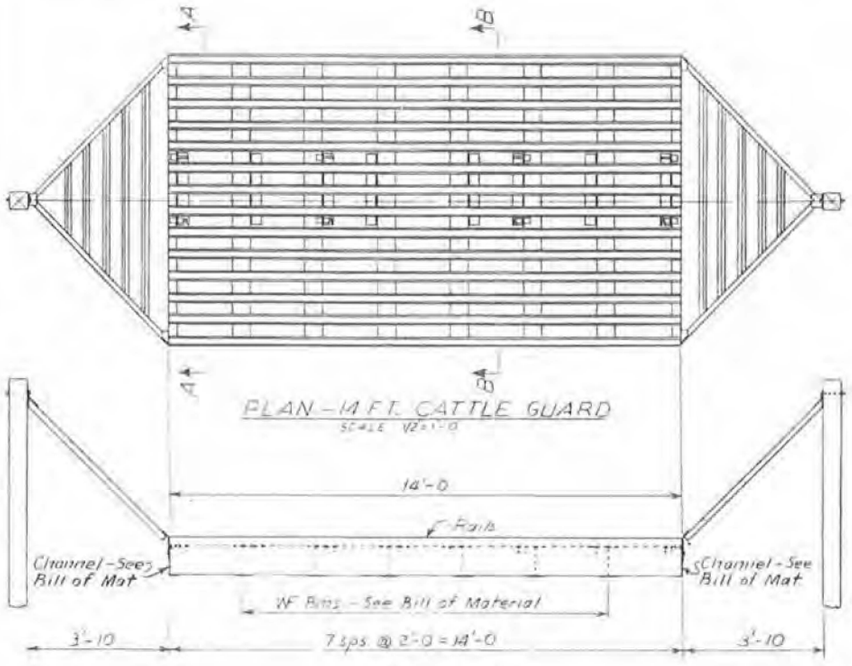

SECTION A-A
SCALE 3/4"=1'-0




SECTION B-B
SCALE 3/4"=1'-0




⚠ ALTERNATE RAIL SPACING
SCALE 3/4"=1'-0




ELEVATION
SCALE 1/2"=1'-0

PLAN - 14 FT. CATTLE GUARD
SCALE 1/2"=1'-0

## BILL OF MATERIAL

| DESCRIPTION | MARK | NO | HS20 SIZE | HS30 SIZE |
|---|---|---|---|---|
| Channel | B1 | 2 | 8C11.5x8'-0" | 10C15.3x8'-0" |
| | | | | |
| Wide Flange | B3 | 6 | 8WF17.0x8'-0" | 10WF21x8'-0" |
| ** Rails | J | 2 | See Detail | See Detail |
| ** Rails | K | 9 | " " | " " |
| ** Rails | m | 3 | See Detail | See Detail |
| Tie Angle | ca | 4 | L 3½"x2½"x¼" | L 3½"x2½"x¼" |
| Locking Angle | d | 12 | L 1½"x1½"x⅜" | L 1½"x1½"x⅜" |
| Locking Bar | e | 4 | ⅜"ø x 0'-7½" | ⅜"ø x 0'-7½" |
| Tie Angle | cb | 4 | L 3½"x2½"x¼" | L 3½"x2½"x¼" |
| Hinge Bar | f | 4 | ⅜"ø x 0'-5½" | ⅜"ø x 0'-5½" |
| Wing Angle | A1 | 4 | L 2"x2"x¼" | L 2"x2"x¼" |
| " " | aa | 2 | L 1½"x1½"x¼" | L 1½"x1½"x¼" |
| " " | ab | 2 | " | " |
| " " | ac | 2 | " | " |
| " " | ad | 2 | " | " |
| Wing Angle | ae | 2 | L 1½"x1½"x¼" | L 1½"x1½"x¼" |
| Gusset | g | 2 | 12.4x¼"x0'-7 | 12.4x¼"x0'-7 |
| Gusset | h | 4 | 12.4x⅜"x0'-11 | 12.4x⅜"x0'-11 |
| Shim | s | 12 | | 5½"x⅜"x0'-10 |
| | | | | |
| Machine Bolts | | 2 | ½"ø x 7½" | ½"ø x 7½" |
| Machine Bolts | | 4 | ½"ø x 1¼" | ½"ø x 1¼" |
| Link Chain ② | | 4 | No. 4/0 | No. 4/0 |
| Lock Washers | | 4 | ½"ø | ½"ø |
| Mall Iron Washers | | 2 | ½"ø | ½"ø |
| Total Wt of Steel & Hwd (Est) | | | 2,620 lbs | 2,930 lbs |

⚠ * May be shortened to 7'-9". See Alternate rail spacing

### NOTES

DESIGN: Cattle guard is designed for H S20 loading or H S30 loading as noted in the Bill of Material.

** STRUCTURAL STEEL: Rails for H S20 loading shall be formed from structural steel conforming to A.S.T.M. designation A36. Rails for H S30 loading shall be formed from structural steel conforming to A.S.T.M. designation A572 Grade 45. All other structural steel shall conform to A.S.T.M. designation A36.

WELDING: All welding shall conform to A.W.S. Specifications. Weld rails marked "m" in center section to all angles marked "ca" and "ch" only. All other rails shall be welded to each wide flange and channel the full width of the flanges on each side of the rails.

PAINTING: All steel shall have one shop coat of zinc-chromate paint (AASHO M-142) and one shop coat of aluminum paint (AASHO M-69).

⚠ ALTERNATE CATTLE GUARD LENGTH: At the fabricators option a 7'-9" cattle guard may be used in lieu of the 8'-0" cattle guard. See Alternate Rail Spacing detail for use with 7'-9" cattle guard.

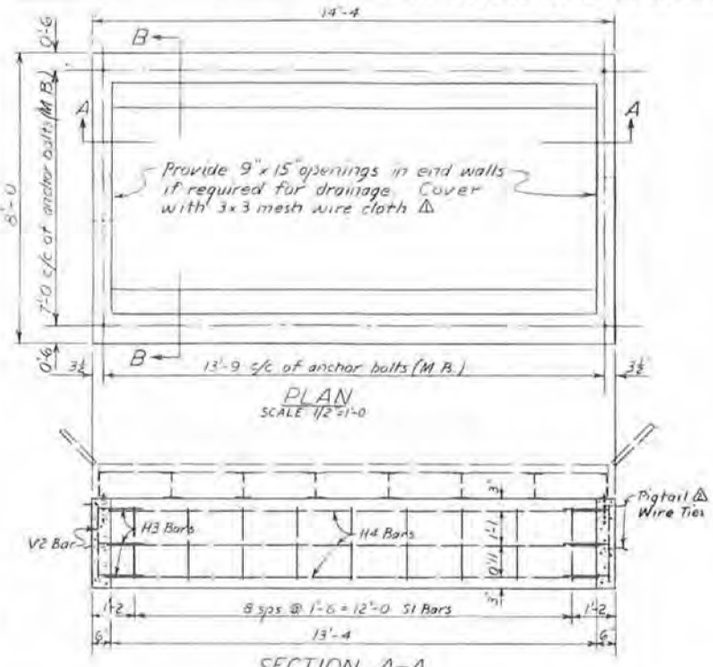
⚠ Revised ---------- 4/1/70 HWB
⚠ Revised ---------- 2/24/71 HWB
⚠ Revised ---------- 5/17/71 HWB
⚠ Revised ---------- 10/25/72 HWB

REDUCED PLAN — MODIFY SCALES ACCORDINGLY

# STANDARD CATTLE GUARD 14 FT RDWY WIDTH

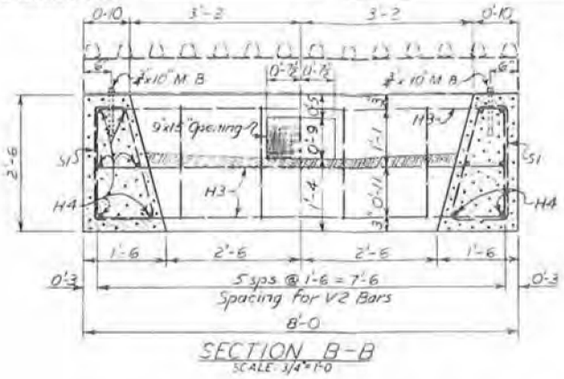
PLAN 220-10

DWG. NO. R927-1

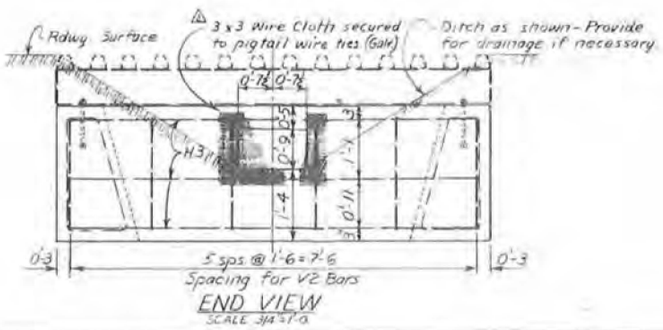

14'-4
B
A
Provide 9"x15" openings in end walls if required for drainage. Cover with 3x3 mesh wire cloth ⚠
8'-0
7'-0 c/c of anchor bolts (M.B.)
13'-9 c/c of anchor bolts (M.B.)
Pigtail ⚠ Wire Ties
V2 Bar
H3 Bars
H4 Bars
8 spcs @ 1'-6 = 12'-0 S1 Bars
13'-4

PLAN
SCALE 1/2"=1'-0

SECTION A-A
SCALE 1/2"=1'-0

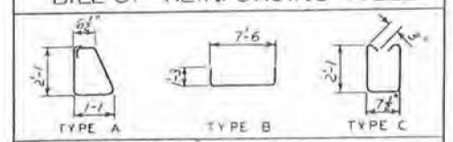



SECTION B-B
SCALE 3/4"=1'-0


Rdwy. Surface
⚠ 3x3 Wire Cloth secured to pigtail wire ties (Galv.)
Ditch as shown - Provide for drainage if necessary
H3
5 spcs @ 1'-6 = 7'-6
Spacing for V2 Bars

END VIEW
SCALE 3/4"=1'-0

## BILL OF REINFORCING STEEL




| STRAIGHT BARS | | | | BENT BARS | | | | |
|---|---|---|---|---|---|---|---|---|
| MARK | SIZE | NO. | LENGTH | MARK | SIZE | NO. | TYPE | LENGTH |
| V2 | 4 | 12 | 2'-1 | S1 | 4 | 18 | A | 6'-6 |
| H4 | 4 | 12 | 13'-6 | H3 | 4 | 6 | B | 10'-0 |

Wt. of reinforcing steel ..... 243 lbs.
Vol. of concrete ..... 3.59 cu. yds.

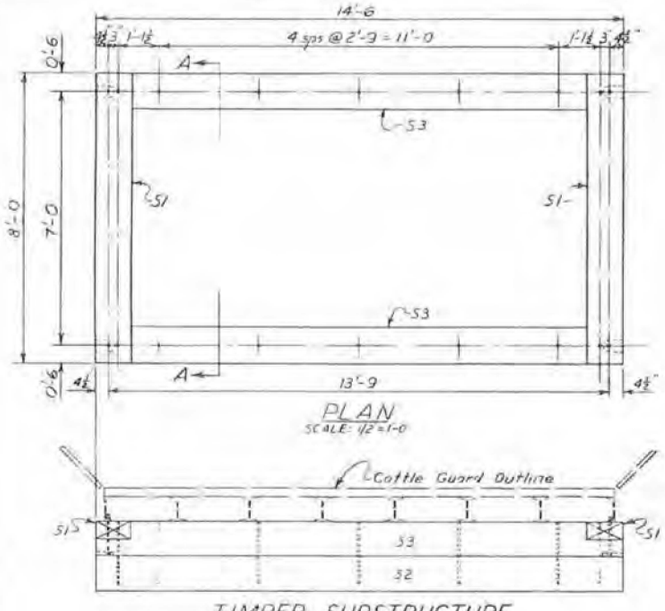
### NOTE

Concrete shall have a minimum 28 day compressive strength of 3000 psi. Reinforcing steel shall be intermediate grade in conformance with AASHO M-31 and M-137. Reinforcing steel shall have 2" of cover minimum. Bar bending details refer to outside of bends. Cutting and bending shall conform to AC. 315-57.

## BILL OF MATERIAL

| | DESCRIPTION | QUANTITY |
|---|---|---|
| | Anchor Bolts, $\frac{3}{4}$"ϕ x10" M.B. | 4 |
| | Bevel Washers, $\frac{3}{4}$" | 4 |
| ⚠ | Wire Ties, 20 ga. annealed | 8 #± |
| ⚠ | Wire Cloth, 3"x3" mesh, (Galv.) | 6 sq. ft. |
| | Posts, 6"x6"x8'-0 Treated | 2 |

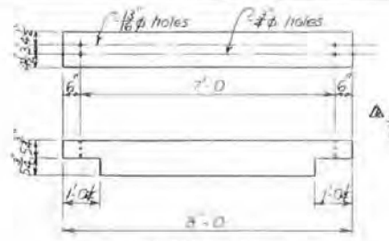
Total Wt. of Hardware ..... 6 lbs.
Posts ..... 48 F.b.m.



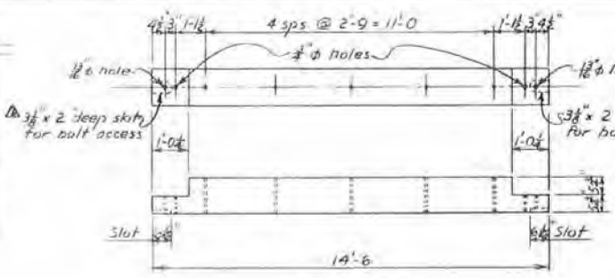

PLAN
SCALE: 1/2"=1'-0



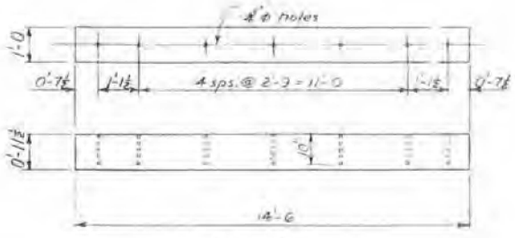

TIMBER SUBSTRUCTURE
SCALE 1/2"=1'-0




SILL-S1
8"x12"x8'-0 S2S




SILL S3
12"x12"x14'-6 S2S




SILL-S2
8"x12"x14'-6 S2S

### NOTES

All lumber shall be of Douglas Fir or Larch and of No.1 Grade.

All lumber shall be completely and accurately fabricated before treatment. Holes shall be bored on a true line to insure fit with adjacent piece.

After fabrication all lumber shall be pressure treated by the empty cell process with creosote and petroleum oils or with pentachlorophenol in accordance with the current specification C2 of the American Wood Preservers Association Standards. All lumber shall be incised on all four faces before treatment. All lumber shall be marked where such piece mark is indicated in the Bill of Lumber.

## BILL OF LUMBER

| DESCRIPTION | MARK | FINISH | NO. PCS. | SIZE | LENGTH |
|---|---|---|---|---|---|
| Sill | S1 | S2S | 2 | 12x12" | 8'-0 |
| Sill | S2 | S2S | 2 | 12x12" | 14'-6 |
| Sill | S3 | S2S | 2 | 12x12" | 14'-6 |
| Post | P1 | Rgh | 2 | 6"x6" | 8'-0 |

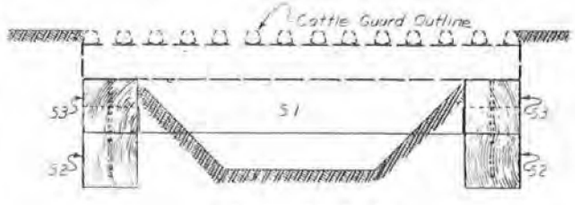
Lumber ..... 936 f.b.m.

## BILL OF MATERIAL

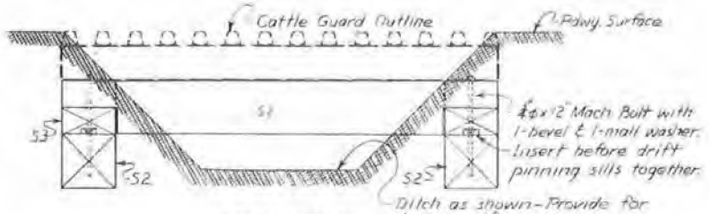
| DESCRIPTION | QUANTITY |
|---|---|
| Drift Pins, $\frac{3}{4}$"ϕ x 21" reinf. sH | 14 |
| Anchor Bolts, $\frac{3}{4}$"ϕ x 12" M.B. | 4 |
| Bevel Washers, $\frac{3}{4}$" | 4 |
| Mall. Iron Washers, $\frac{3}{4}$" | 4 |
| | |

Total Wt. of Hardware ..... 45 lbs.

REDUCED PLAN—MODIFY SCALES ACCORDINGLY




SECTION A A
SCALE 1/2"=1'-0


Cattle Guard Outline
Rdwy. Surface
S1
S2
S2S
¾"ϕx12" Mach. Bolt with 1-bevel & 1-mall washer. Insert before drift pinning sills together.
Ditch as shown - Provide for drainage if necessary

END VIEW
SCALE 3/8"=1'-0

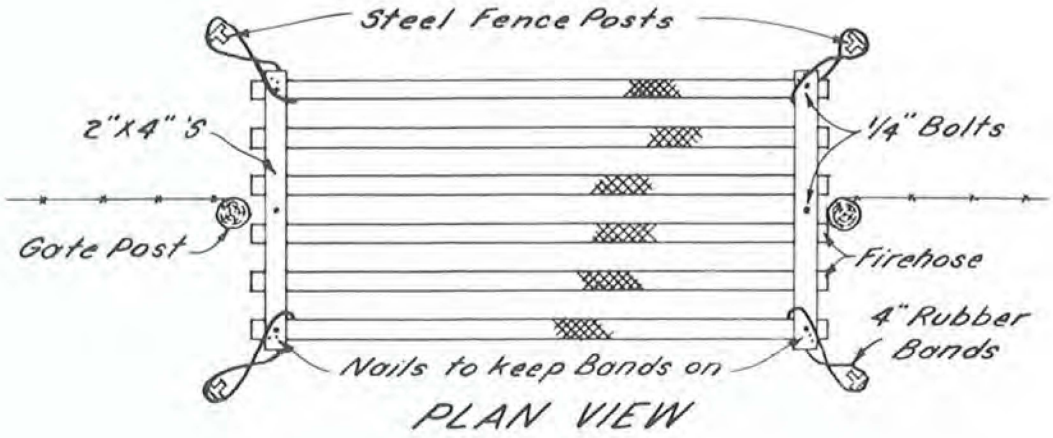
⚠ Revised ..... 12/4/72 PJM
⚠ Revised ..... 4/27/70 HJB

# STANDARD CATTLE GUARDS 14 FT. RDWY. WIDTH

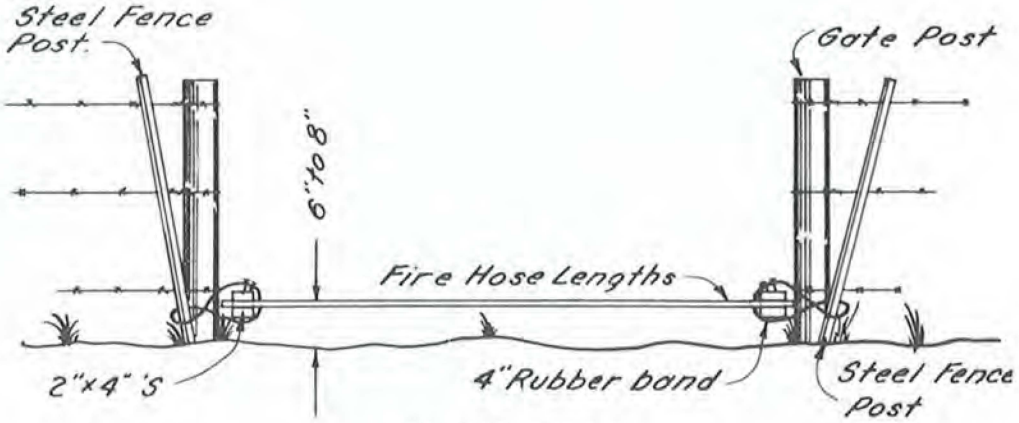
PLAN 220-10a

DWG. NO R927-2

# TEMPORARY FIREHOSE CATTLEGUARD




PLAN VIEW

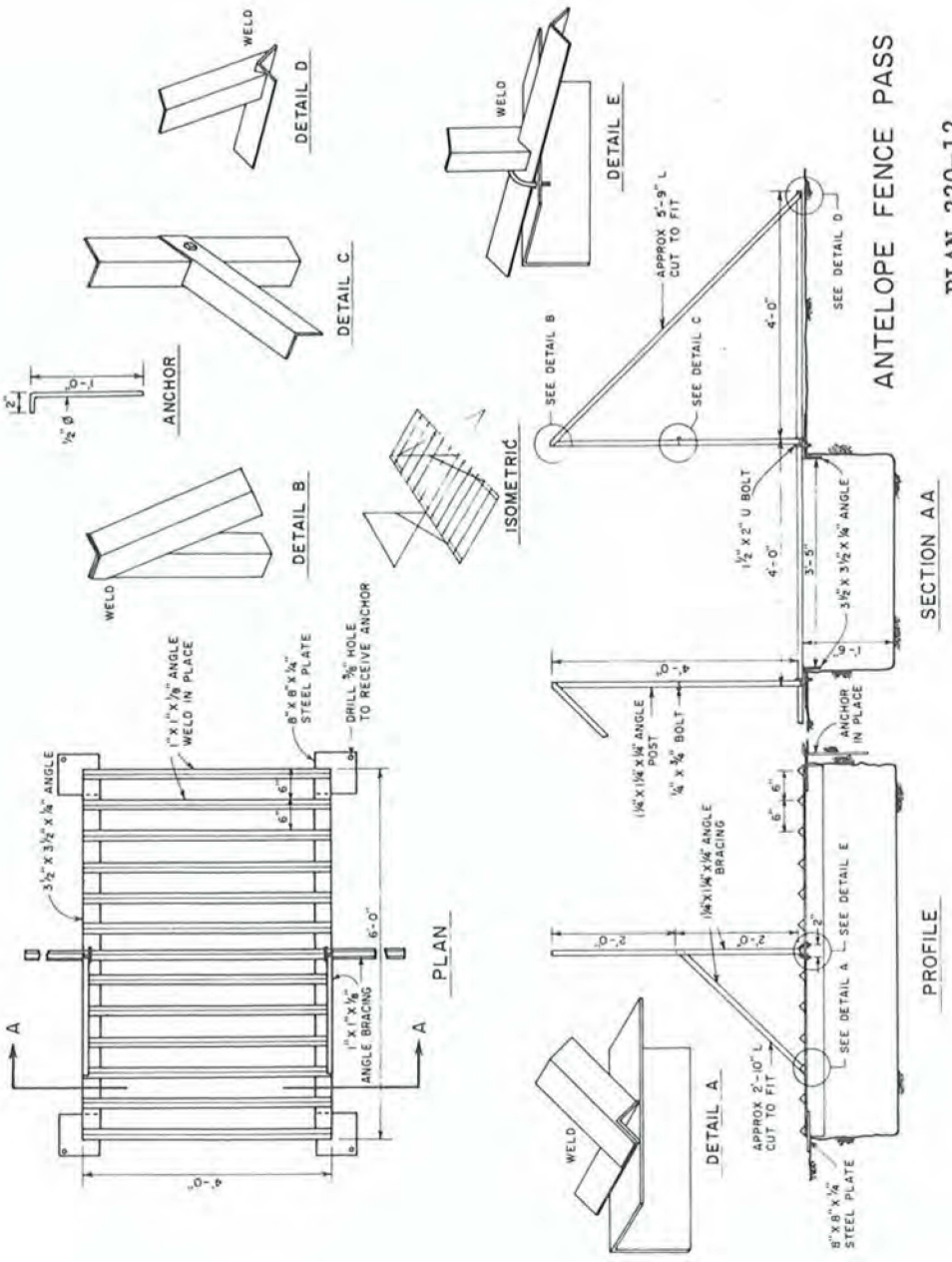


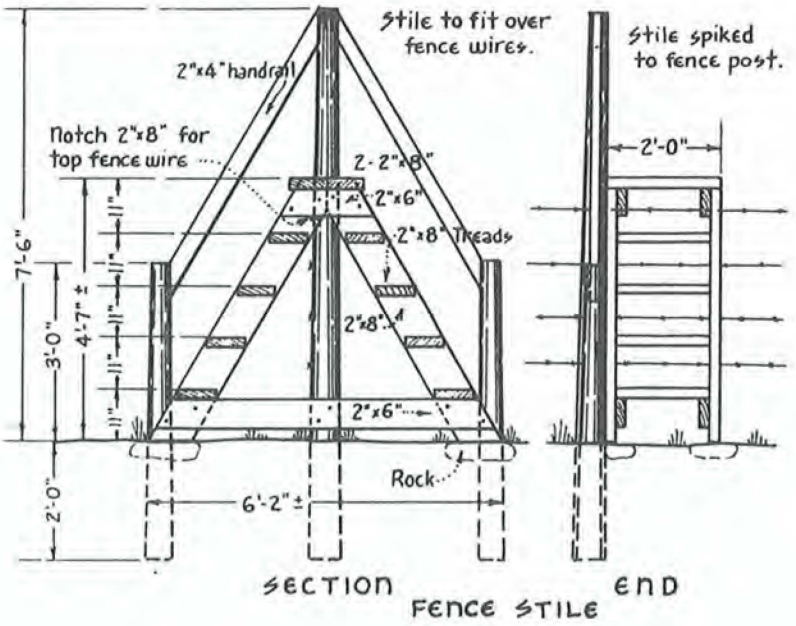

ELEVATION

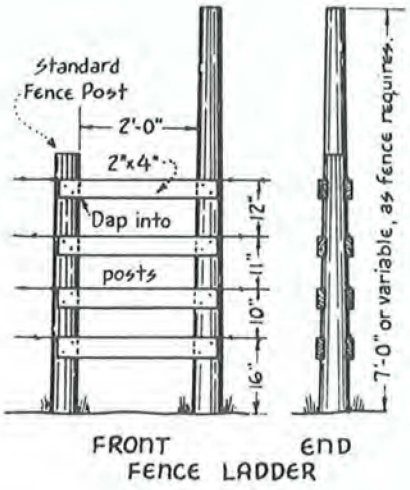
MATERIALS NEEDED:

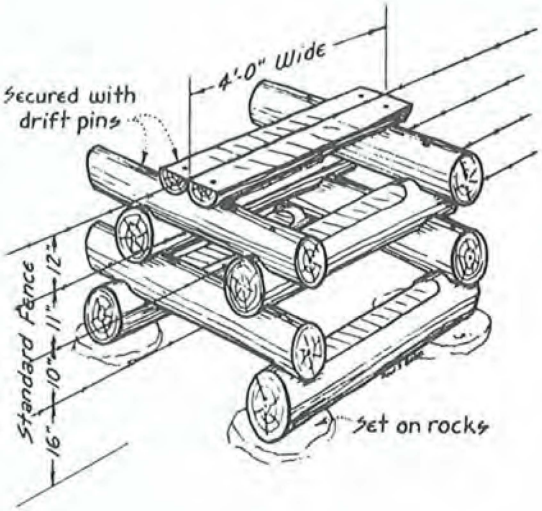
| | |
|---|---|
| 4 | PIECES 2- BY 4-INCH BY 7-FOOT LUMBER. |
| 6 | 1/4- BY 4-INCH MACHINE BOLTS. |
| 12 | 5/16-INCH WASHERS. |
| 44 | 16D NAILS. |
| 150 FEET | CONDEMNED 1½-INCH COTTONJACKET FIREHOSE (YELLOW IF AVAILABLE) CUT INTO 14-FOOT LENGTHS. |
| 2 | CONDEMNED INNERTUBES (CUT INTO 4-INCH BANDS). |
| 4 | 5-FOOT STEEL FENCEPOSTS. |
| 30 FEET | BALING WIRE (TO CLOSE IN ENDS). |
| 4 | 1½-INCH SECTIONS OF SPLIT FIREHOSE (TO MOUNT ON STEEL POST TO KEEP POST FROM CUTTING RUBBERBANDS WHEN GUARD IS MOUNTED). |

PLAN 220-11


ANTELOPE FENCE PASS
PLAN 220-12
PLAN
SECTION AA
PROFILE
ISOMETRIC
DETAIL A
DETAIL B
DETAIL C
DETAIL D
DETAIL E
ANCHOR
WELD
SEE DETAIL A
SEE DETAIL B
SEE DETAIL C
SEE DETAIL D
SEE DETAIL E
APPROX 2'-10" L CUT TO FIT
APPROX 5'-9" L CUT TO FIT
3½" X 3½" X ¼" ANGLE
1" X 1" X ⅛" ANGLE WELD IN PLACE
8" X 8" X ¼" STEEL PLATE
DRILL ⅝" HOLE TO RECEIVE ANCHOR
1" X 1" X ⅛" ANGLE BRACING
1¼" X 1¼" X ¼" ANGLE POST
¼" X ⅜" BOLT
1¼" X 1¼" X ¼" ANGLE BRACING
½" X 2" U BOLT
3½" X 3½" X ¼" ANGLE
ANCHOR IN PLACE
6'-0"
4'-0"
3'-5"




## STILES & FENCE LADDER

PLAN 220-13

STRUCTURAL RANGE IMPROVEMENT HANDBOOK

# CHAPTER 300 - RANGE WATER DEVELOPMENTS

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| | |
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| Plan 370-11 | Closing Water Trough |

STRUCTURAL RANGE IMPROVEMENT HANDBOOK

CHAPTER 300 - RANGE WATER DEVELOPMENTS

310 - GENERAL. It is the objective of the Forest Service to obtain sufficient quantities of water to provide for development, use and management of all resources.

An adequate supply of livestock water that is well distributed is essential for proper management of any range. Ordinarily, additional water developments are needed to supplement natural water supplies under an intensive system of management. Thus the development of water is usually a high priority improvement under any pasture management system.

Stock water for range livestock is obtained from five principal sources--streams, springs, wells, trick tanks, and stock ponds. Expanding the effective area of water developments by use of plastic pipe should be considered where feasible.

1. Water Rights for Stock Water Developments. See FSM 2541.23.

Water will not be developed on private land without first obtaining a right-of-way or deed from the owner. Water rights will also be acquired in accordance with applicable State laws.

2. Water Requirements for Livestock

The quantity of water an animal needs depends mostly upon the kind of food it is eating and on weather conditions. For water development estimates, it is well to figure 10 to 12 gallons per day for cattle and horses, and 1 to 1½ gallons per day for a ewe and lamb. Cattle should not travel more than one-half mile to water in rough range or one mile in rolling or level areas. Sheep should not travel over one mile to water on rough range and two miles on rolling or level country. Most of the National Forest ranges would be classified as rough. Ideally, pasture type management systems should provide sufficient water to water livestock within a 2-hour period.

3. Placement of Troughs

a. Location. Troughs should be on the level or on gradual slopes. The construction and long-range maintenance costs may justify piping water some distance to a suitable site. All trough sites should be well drained and free of obstructions. Free and easy livestock access to the full drinking area of the trough is very important.

It may not be desirable to locate stock tanks on ridge tops because they become tempting targets for inconsiderate shooters. It usually is best to locate them so they are not noticed by the general public, such as placing them among trees, in small depressions, and behind ridges. This could increase maintenance to some extent from debris, but will reduce the chance of vandelism.

Soil is often trampled and eroded away enough to make it difficult for calves to drink. Carefully chosen sites may reduce but will not always avoid this. An apron of concrete, rocks, or other material may be needed around the tank.

Sometimes calves will get pushed or jump into larger stock tanks to get to water, but are unable to get out afterwards. It may be advisable to place a second and much smaller trough for the calves, downhill from the larger trough. The water level in the second tank can be controlled by a float valve.

b. Support. Inadequate support is the main cause of trough failure and high maintenance costs. Sill material must withstand the weight of trough and water, and the foundation and trough protection must withstand rubbing and trampling by livestock without being displaced. Concrete, stone, steel, or treated timber material should be used for support and protection. Concrete for foundations should be in proportions of 1 cement:2½ sand:5 gravel.

4. Lead-in Pipe

a. Size. Large enough to carry all the water, minimum size 1¼-inch diameter.

b. Material. Galvanized iron or plastic pipe. Plastic pipe has the following advantages:

(1) Lightweight, easily transported.

(2) Lower cost.

(3) Not usually damaged by freezing.

c. Installation

(1) Straight as possible.

(2) All downgrade of 1 percent or more, if possible. Reverse grades require a drain at each low spot. Mark drain locations above the ground.

(3) Iron pipe must be protected from freezing by burying below frostline or by shutoff and drainage (an expensive procedure).

(4) Plastic pipe must be protected from livestock trampling and rodent damage.

(5) Protect the inlet of the pipe with a tee and screen. The screen can be omitted if there is little chance of debris getting into the pipe.

(6) Protect the pipe from being moved out of position at the trough. This is a common failure of water developments.

(7) If pipe is above ground, it should be well supported the entire length by fastening to a pole (in case of plastic pipe) and protected with a fence.

(8) Install a "T" in the lead-in pipe at the base of the trough with a plug to facilitate cleaning and draining.

5. Overflow or Outlet. Overflow water should be piped a sufficient distance from the trough to prevent boggy areas in close proximity to the trough. Inlet of this pipe should have a reverse bend or elbow, tapped with antisiphon hole, to prevent plugging. A "T" placed sideways on the inlet of the overflow pipe will also prevent plugging and siphoning. The discharge end of the pipe should be protected with rocks. The water level in the tank should be maintained at about 2 inches below the rim. The overflow should be one-half inch larger than the supply line, if the latter flows full. Consider this when purchasing troughs with built-in overflows. If the water development interrupted spring flow into a creek bottom or natural drainage, the overflow should be returned to the creek bottom to aid the maintenance of the riparian habitat.

6. Moss Control. A green algae growth, commonly called "moss," grows in many stock-water troughs. The growth of this plant can be controlled with blue vitriol (crystallized copper sulfate). To prevent contact corrosion of galvanized surfaces and control solution concentration, these crystals should be placed in a bottle with small notch in the cork. A copper screen, wire, or other copper object, left in the spring box or trough will accomplish the same purpose.

7. Coordination with Other Uses

a. Wildlife. A floating board with one end hinged to the top inside edge of the tank will enable birds to drink when water is low and reduce bird and rodent drownings. The floating board should be

arranged so that it is near the edge of the tank rather than extending from edge to center.

Fences protecting water sources from cattle trampling will enhance growth of vegetation valuable to grouse watering there. This may justify including an area larger than needed to protect the water source.

Do not develop water that will cause livestock to overuse critical winter game forage.

When developing plans for any range improvement, be sure that wildlife needs are met, especially if control of water is anticipated to control livestock. Also, there may be opportunities for developing water specifically for wildlife by tapping into pipelines or using spur lines. When planning water developments for livestock, this and other potential uses should be considered.

b. Watershed. Livestock concentrate at water developments. Consider this at sites where trampling may start erosion.

Raw cuts from construction of earthfill dams may require fencing, seeding, mulching, or other protection.

c. Recreation. Signs should be placed at wells and springs cautioning people that the water may not be safe for human consumption.

## 320 - SPRING AND SEEP DEVELOPMENT

1. General. Before planning a development at a spring or seep, it is essential to check the flow over a reasonable period of time to be certain of the quantity and reliability of the water supply.

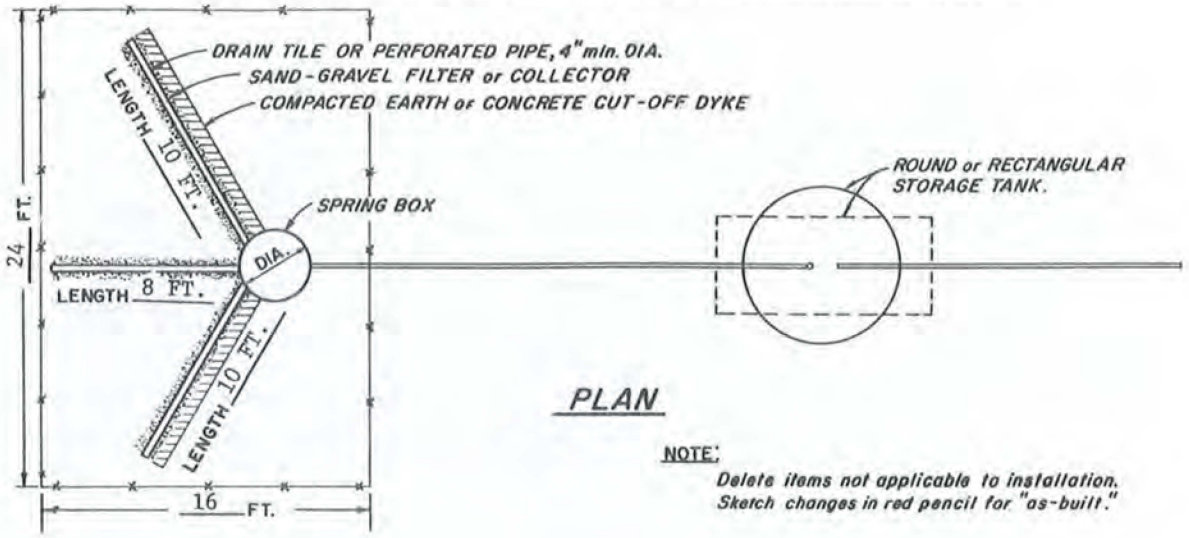
Intermittent springs may be developed providing water is available during the intended period of use. Storage tanks are used where water supply is slow or intermittent. Where storage tanks are used, the outlet should be at least 2 inches in diameter in order to refill troughs rapidly.

2. Water Rising Over a Large Area. Concentrate the water at one place with surface ditches, perforated composition tile, unglazed open-jointed tile, or rock-filled trenches. A spring or seep should be dug down to firm ground, hardpan, or rock to obtain the largest flow and to prevent the water from bypassing the development--water is collected in a head box. Tile laid in wet bogs needs considerable gravel to keep it from plugging. Plastic sheeting laid over the top layer of gravel will extend the life of the development by preventing

STRUCTURAL RANGE IMPROVEMENT HANDBOOK

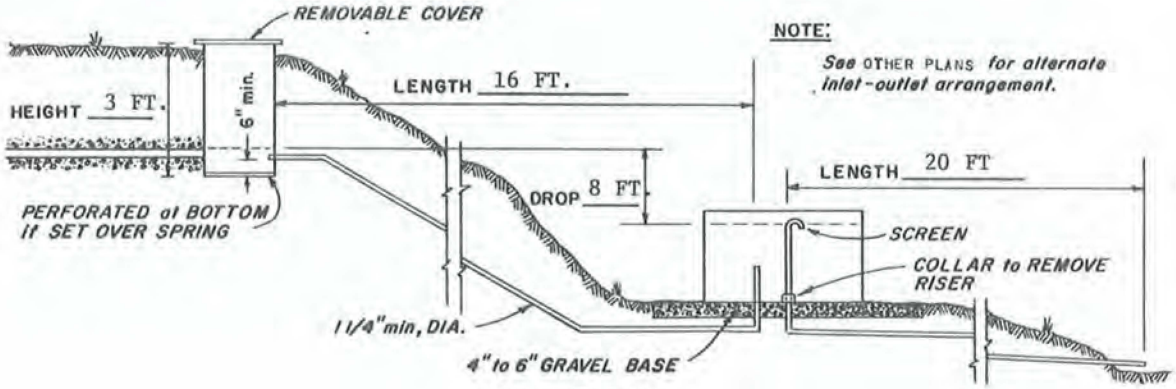
Exhibit 1

# SPRING and SEEP DEVELOPMENT PLAN




PLAN

NOTE:
*Delete items not applicable to installation. Sketch changes in red pencil for "as-built."*




NOTE:
*See* OTHER PLANS *for alternate inlet-outlet arrangement.*

SECTION

TANK: PLAN NO. 370-9 SHAPE round GALLONS 752
SPRING BOX: PLAN NO. 320-3 Culvert
COLLECTION SYSTEM: PLAN NO. ATTACHED Perforated
SUPPLY PIPE: DIAMETER 1¼" LENGTH 20 TYPE 80 PSI (MIN. 80 P.S.I.)
DRAIN PIPE: DIAMETER 2" LENGTH 22 TYPE 80 PSI
FITTINGS: 180° reverse turn, 90° elbow

FENCE: FEET 80, PLANS NO. 210-27
NO. POSTS 10 TYPE wood ROLLS WIRE -
EXCAVATION, CU. FT. 3 HAND X MACHINE
GRAVEL, CU. YD. 7.5 CONCRETE -
REINFORCING STEEL None
OTHER:

SPRING NAME School-Marm
ALLOTMENT Home Creek
LOCATION SW¼, S 26, T. 35, R. 46 E.
PERMITEE Wiechman and Hanic
IDENT. NO. 0-0312
PLANNED BY Morin
DATE 7/28/77
CHECKED BY Uivary
DATE 7/30/77
INSTALLED BY Hanick & Wiechman
DATE 8/30/77
INSPECTED BY Morin
DATE 9/15/77
COST $1,000

NOTE: FILL IN QUANTITY, LENGTH, SIZE, AND TYPE OF MATERIALS NEEDED. REFER TO CHAPTER 300, STRUCTURAL RANGE IMPROVEMENT HANDBOOK, FSH 2209.22 R1. SKETCH LOCATION ON BACK AND SHOW BEST ACCESS AND MILEAGE. INDICATE IF THERE IS VEHICLE OR OTHER ACCESS FOR CONSTRUCTION. ATTACH APPLICABLE DETAIL PLANS FROM CHAPTER 300, FSH 2209.22 R1.

PLAN 320-1

mud from impregnating the gravel from above. Tile should be laid on an even downgrade. The joints of unglazed open-jointed tile should be shielded by a narrow strip of roofing paper lapped over the top of each joint. Tiled areas, and areas where trenches or reservoirs are dug or blasted to collect and concentrate water, should be fenced.

3. Water Rising From a Small Area or Single Source. Tiling, buried 18 to 24 inches, which picks up all the water so that the surface dries up, does not require fencing.

A single, concentrated source may sometimes be picked up completely with a buried headwork. If it collects all the water and dries the surface, no fence is needed. However, if there's any chance of significant trampling in the collection area, the investment to fence the site would be minimal compared to the long-range benefits.

Certain plants, such as wild iris, are indicators of sites where water might be developed. A soil scientist or geologist may be able to give valuable assistance.

4. Head Boxes. Head boxes serve as collection basins and settling ponds to prevent trash and mud from getting into the pipes and troughs. A good head box size is 3 feet by 3 feet by 3 feet tall. They may be made of wood, concrete, rock masonry, or metal, such as a section of pipe culvert. Corrosive metal should have a good coat of asphalt-base paint. Treated wood is preferable to untreated unless rot-resistant species are used.

5. Development Plan. Plan 320-1, Spring and Seep Development Plan, may be used for designing the development and for a materials list (see exhibit 1). This plan may also be supplemented with applicable detail plans from this chapter. In combination, these are adaptable to most spring and seep development situations. After construction, a copy of Plan 320-1 should be retained in unit files for an "as built" record and for use in improvement maintenance. Sufficient copies should be prepared initially for planning and construction needs and for a permanent "as built" record.

## 330 - STOCK PONDS

### 330.1 - Dams or Reservoirs

1. Selection of Site. The following points should be kept in mind when selecting a site for a reservoir:

a. When reservoirs are to be for livestock and wildlife use only, they should be no larger than is needed to serve the forage area

in which they are located. When they are to serve as water sources for fire suppression, road watering for timber sales, etc., the cost of surveying and construction should be shared by the benefitting functions.

b. The most suitable soils for dams are clays with a fair proportion of sand and gravel (one part clay to two or three parts grit). Straight clay soils crack badly upon drying and are apt to slip when wet.

Soils with an impervious layer of clay near the surface, underlain with a gravel strata, are not adapted to excavated water developments. Under such conditions, the soil surface in the impounding area cannot be disturbed unless waterproofed later. Therefore, fill material for the dam must be surface material borrowed outside the storage area.

c. The watershed above the dam should be large enough to provide sufficient water to fill the dam without excessive danger of flood damage.

d. The most economical site is one along a natural drainage where the channel is narrow, relatively deep, and the bottom is easily made watertight. The channel grade immediately above the dam should be as flat as possible.

e. Livestock should have easy access to the water.

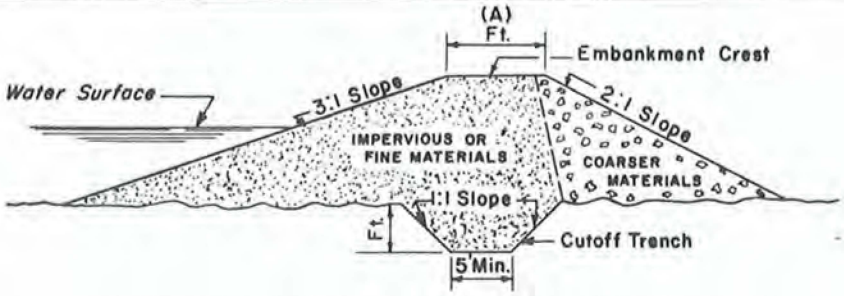
f. If possible, the dam should be located to take advantage of a natural spillway.

g. In some situations, it has been found desirable to place water developments on pasture boundaries so that one development can provide water for two or more pastures. In such cases, fence in about an acre around the development. Place gates so this water yard can be made available to livestock from any one of several adjacent pastures.

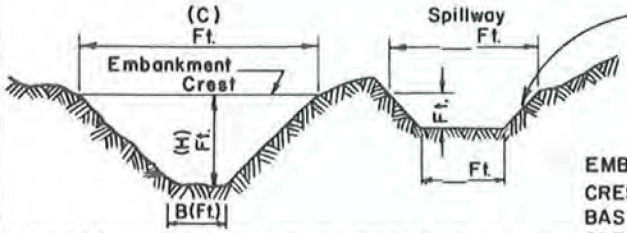
2. Forest Service Requirements. Refer to FSM 7513 for design review requirements for dams. A pit or dugout not employing a dam may not need review by an engineer, but engineering services may still be desirable.

3. Size and Depth of Reservoir. These will depend on drainage area for the site, water requirements, and workability of soil. A reservoir should be at least 7 feet deep and 50 feet in diameter for sheep. Smaller reservoirs may serve for cattle. There must be enough slope for entrance by livestock to prevent sloughing.

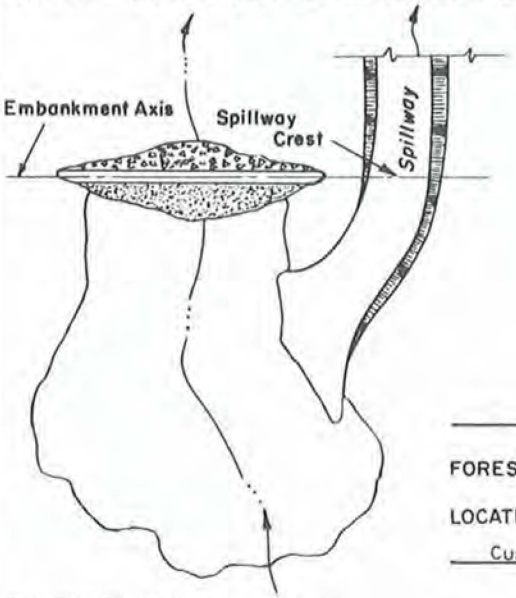
# STOCKWATER EMBANKMENTS




MAXIMUM CROSS-SECTION OF EMBANKMENT




CROSS-SECTION OF EMBANKMENT SITE




DEVELOPMENT LAYOUT

## EMBANKMENT

EMBANKMENT HEIGHT(H) 19 FT.
CREST WIDTH (A) 125 FT.
BASE LENGTH (B) 15 FT.
CREST LENGTH (C) 10 FT.
VOLUME 2432 CU. YDS.
RESERVOIR CAPACITY 0.25 A.F.

## WATERSHED

DRAINAGE AREA 100 ACRES
AVERAGE ELEVATION 3500
AVERAGE SLOPE(%) 45
SOIL TEXTURE
SANDY CLAY AND ROCK

TYPE AND DENSITY OF COVER
GRASS AND LIGHT BRUSH--50% COVER

SURFACE STORAGE
NONE (GULLIES)

SCHILLER STOCK WATER POND

FOREST INVENTORY NO. 0-0047

LOCATION-SEC. 6 TWP. 2S RANGE 46E

CUSTER NAT'L FOREST MONTANA STATE

PLAN 330-1

4. Design Criteria

a. A standard plan, Plan 330-1, Stockwater Embankments, with all embankment, watershed, and section data and dimensions filled in, should be prepared by the District Ranger, with engineering help, for each project (see exhibit 2). Copies of the plan with standard specifications should be furnished to contractors engaged in construction of small dams, and to all Forest personnel concerned with responsibility for supervision of construction. Copies of the completed plan will be filed on the Ranger District.

b. The maximum discharge for a 25-year flood frequency from the watershed area shall be computed by a qualified engineer or watershed specialist by generally accepted hydrologic methods. Where the recession hydrograph for the watershed is of several days' duration and a spillway can be economically justified, the design can include a principal spillway pipe.

c. Spillways need not be provided in those cases where the cost of replacement, upon failure of the dam, does not exceed the cost of the spillway based on design peak discharges for a 25-year frequency flood. In this case, a written justification showing data, costs, etc., shall accompany the plans for the approval of the Forest Supervisor.

d. The spillways shall be located in stable formations that are not easily eroded and shall extend to a point well downstream from the dam embankment.

The inlet to the spillway shall have an adverse grade of not less than 3 percent leading up to a level control section 5 to 10 feet in length before breaking to the exit channel grade. The grade of the exit channel shall not produce erosive velocities for the type of material in the channel. The heavier and tougher the sod cover the higher the safe velocities will be, starting at about 3 feet per second for bare soil and increasing to 7 or 8 feet per second for tough sod.

The width at the entrance to the spillway shall be at least 50 percent greater than the width at the control section.

e. The size of the spillway shall be adequate to carry the entire discharge from the watershed above the water impoundment with a net freeboard of not less than 2 feet above high water level during flood stage.

f. The depth of the spillway notch (vertical distance from the highest point in the spillway channel to the top of the embankment) shall not be less than 4 feet.

g. The side slopes of the spillway will vary to suit the erosive characteristics of the soil formation.

h. The embankment slopes shall be 3 to 1 upstream and 2 to 1 downstream or shall provide an equivalent cross section area. The crest width of the embankment shall be not less than 10 feet. Centerline stakes shall be set on the axis of the dam, and slope stakes shall be set for the embankment.

i. When the embankment forms one side of the spillway channel, the embankment shall be protected with a substantial riprap covering to prevent erosion. Cut stakes shall be set for the excavation of the spillway channel.

j. Adequate supervision of construction shall be provided to assure that the embankment and spillway are constructed in accordance with the plan and standard specifications for stockwater embankments.

k. Volume of the embankment shall be computed by the average end-area method.

5. Excavation Equipment. A tractor bulldozer or dragline is best. A dragline is best on boggy ground. Horses and scrapers may be used, where available, and for remote and relatively inaccessible areas.

6. Construction Suggestions

a. The site should be surveyed and staked by an engineer before construction. If suitability of material for an earthfill is questionable, a geotechnical engineer should be consulted.

b. Making stockwater reservoirs by damming off canyons, large gullies, or washes is usually poor practice. More or less natural sites may be found where damming off the watercourse and providing an adequate spillway will make a satisfactory reservoir. Sometimes the headwater flow into a reservoir can be controlled by providing overflows in the lead-in ditch. Gradient should never exceed 1½ percent. On erosive soils, the grade should not exceed 1 percent.

c. A bowl-shaped or deeper excavation will impound more water with less evaporation loss than a shallow, flat structure.

d. Clear the vegetation from a little more than the planned reservoir area.

e. The foundation area of the dam should be plowed or scarified lengthwise of the dam, so there will be a good bond between the foundation and the fill material. If stability and permeability of the foundation material is questionable, it is best to dig a narrow core trench, then fill and pack with damp clay soil.

f. If the material is suitable, the borrow pit should be above the dam so it adds to the depth of the reservoir. Before this is done, however, thorough examination and analysis should be made by a geotechnical engineer and geologist to determine the water holding ability once the borrow is removed. If there is no choice for material and removal of the borrow breaks the natural seal, it will be necessary to artificially seal with bentonite or lining.

g. Start excavation in the center, developing a bowl-like shape, with the dirt deposited in a semicircle on the downhill side. The degree of sideslope should depend on the types of soil. The degree and method of compaction should be determined by a geotechnical engineer. Layer compaction using tractors or hauling equipment may be satisfactory for small, low dams less than 5 feet high. Layers should not exceed 1 foot loose depth. Higher or more hazardous dams may need to be compacted with sheepsfoot rollers or other specialized compaction equipment depending on soil type. The dam should be not less than 10 feet wide at the top and with at least 2 feet freeboard. Allow 10 percent of height for settling.

h. Riprapping the dam face of larger impoundments may be required to prevent erosion from wave action.

i. Where a spring or seep does not lend itself to reservoir construction, it may be best to build the reservoir below and lead the water to it. The water source should be fenced.

j. A water supply pipe should be installed under or through the dam when water is to be used below the dam for stockwater, wildlife, filling fire or spray tanks, or for supplying distribution lines. This pipe is usually in addition to the principal spillway. The water supply pipe should have water-tight joints and be equipped with a suitable valve and strainer at the upper end. For small rates of flow such as needed for filling stock water tanks, 1½-inch diameter pipe is generally sufficient. Larger rates of flow will require larger pipe. Water supply pipes should be provided with antiseep collars to retard seepage. Stock water supply can be controlled with a float valve at the trough.

Whenever a water supply pipe is installed, the entire dam and reservoir area should be fenced. Gates can be provided for maintenance access and to allow livestock into the impoundment if the need arises. This arrangement provides clean water for livestock and game, enhances wildlife and bird habitat, and protects the fill, spillway, and banks from trampling damage.

k. Evaporation from open tanks and ponds can be reduced 30 percent by maintaining a film of tallow alcohol, commonly called hexadeconol. Tallow alcohol is applied by using water soluble packets of powdered alcohol, or in wire mesh racks containing alcohol flakes. However, before hexadeconol or any other similar product is used, a complete analysis should be conducted to determine its effect on the environment.

7. Spillway. A natural spillway is best. It should be broad and flat in cross section to prevent cutting. If possible, it should leave the reservoir well above the fill and reenter the channel some distance below, spilling the water on approximately the same gradient as the channel. Avoid spilling water onto steep sideslopes as a gully and headwall will develop that may eventually cut back and breach the impoundment.

The same principles apply for constructed spillways. They should be protected from erosion by reseeding disturbed areas and riprapping if soil is erodible. Dam and spillway areas should be fenced to protect seeded species and to prevent a stock trail developing in the bottom of the spillway, a frequent cause of reservoir failure.

8. Prevention of Seepage. Direct leakage through a dam is usually the result of inferior construction. Special procedures are needed for correction. Stock pond seepage losses commonly decrease with age as a result of deposition of fine sediment and trampling by livestock. When stock ponds do not seal in one or two seasons, consideration should be given to the use of colloidal sealers. Local bentonite clay-sand deposits generally have proved effective for this purpose and are commonly used where available at reasonable cost. Application of this natural material should be at least one inch thick. Bentonite may lose its effectiveness if the stored water contains calcium. Thus, the possible chemical content of the water should be considered in deciding on the method of pond treatment. Generally, bentonite should be applied at the rate of about one pound per square foot, depending on the quality of the bentonite and chemical analysis of the soil. One of the following methods should be followed in application.

a. Remove 4 to 6 inches of soil from the dry reservoir. Smooth the reservoir bottom by hand rake, plane, roller, or similar means. Cover the whole area lightly with an even layer of bentonite at the rate previously determined. Replace the removed soil by carefully spreading it over the bentonite. Roll or tamp the whole area. If it is not desirable to remove the 4-6 inches of soil from the reservoir because of losing natural seal, bentonite may be applied and borrow from outside the reservoir used to cover it.

b. Remove all vegetation, rocks, and similar material from reservoir basin. Smooth the surface reasonably well and plow to a depth of 4 to 6 inches. Allow to dry. Scatter bentonite evenly over the plowed surface (about 1 pound/square foot) and mix with soil by hand rake, spiketooth harrow, or disk. Roll or tamp whole area.

c. If the bentonite is granular and the seepage not too serious, applying the granules directly on the water surface often gives good results. The granules sink and are drawn into the seepage cracks, where they swell or gel to plug the leak.

d. Seepage from many stock ponds in calcium aggregated soils can be greatly reduced by treatment with sodium carbonate without soil compaction. Use granular soda ash which is 99 to 100 percent sodium carbonate ($Na_2CO_3$). The proper amount of sodium carbonate, determined by soil analysis, is broadcast on the soil and mixed into the top 3 to 5 inches. A high lime content shortens the life of any sodium treatment, as does a high organic content of the water.

It is preferable to have several soil samples tested to determine the effectiveness of the sodium carbonate treatment prior to the actual treatment.

Treatment with sodium carbonate should be successful if the following criteria are met.

(1) The depth of the soil overlying sand, gravel, or porous rock should be at least 12 inches.

(2) Clay content should be 15 percent or greater.

(3) Cation exchange capacity (CEC) should exceed 15 milli-equivalents per 100 grams of soil.

(4) In the following calculations, use the information from the soil sample with the highest CEC. The amount of sodium carbonate required for treatment can be estimated with the following equation: $NA_2CO_3 = 0.004\ DA(0.15\ CEC - ES)$ where $Na_2CO_3$ is pounds of sodium carbonate, D is depth of soil to be treated (in inches), A is area to be treated (in square feet), CEC is cation exchange capacity (meq/100g), ES is exchangeable sodium (meq/100g).

(5) The sides and bottom of the pond must be cleared of grass, shrubs, trash, and rocks prior to treatment. Uniformly broadcast the salt on the surface, then work it into the soil by disking or harrowing. Face masks are recommended during salt broadcasting. Soil

compaction is not necessary. The pond is ready to receive water immediately after treatment.

330.2 - Pit Tanks. These are usually excavated on the edge of bogs, wet spots, seeps or very low volume springs. They may also be constructed to catch and store surface runoff. They are best constructed with a dragline, but a bulldozer or large backhoe may also give satisfactory results. These developments differ from a reservoir in that almost all of the impounded water is below the original ground line. No dam, as such, is involved, although the excavated material may be evenly placed on the downhill side. The structure may be fenced and water piped to a trough with float valve, or livestock may have unrestricted access.

Snowbanks are another source of water, particularly on high sheep ranges. A pit tank immediately below a snowbank area may impound enough water for several days' use.

340 - TRICK TANKS. A trick tank is intended to store water in a covered tank or cistern after collection on an impervious apron. Aprons may be of corrugated metal roofing, asphalt and sheet plastic, asphalt and aluminum foil, rubber, or asphalt and sand. Water collected off the apron is stored in a metal, concrete, plastic or butyl tank and taken by pipeline to a trough with a float valve. Since costs are relatively high, other types of water development should be explored before this method is selected.

Trick tanks may provide water to extend livestock use into poorly watered forage areas. On some ranges, runoff may be collected from snowdrifts. Snow fences can be constructed to pile up large drifts on the catchment apron. Trick tanks may be more economical than hauling, or possibly used when hauling is not feasible.

If possible, trick tanks should be built at elevations that will allow piping water by gravity flow to other dry portions of the range. The catchment area should be on a gentle slope, not exceeding 10 percent, so the apron can be placed on smoothed ground with a minimum of earthwork.

1. Size of Apron and Cistern. In figuring the storage cpacity and apron size, give consideration to the season the area will be grazed. If grazed during the dry period when no refilling can be expected from precipitation, the storage capacity will need to be large enough to water the stock through the use period.

To determine size of apron and cistern needed:

a. Call the carrying capacity in animal months to be grazed from this water development "X."

b. Call the amount of water used per animal month "Y" (this is 45 cubic feet for cattle and 5 cubic feet for sheep).

c. Convert the average annual precipitation (usually given in inches) to feet (i.e., 9 inches equals .75 foot) and call this figure "Z."

d. X times Y = cubic feet of storage needed in cistern. A 10 percent safety factor may be added. There are 7.48 gallons in 1 cubic foot of water.

e. $\frac{\text{X times Y}}{Z}$ = square feet of apron needed

f. Example - with 20 head of cattle for 2 months where the annual precipitation is 15 inches:

$40\text{AMx}45\text{ft}^3 = 1800\ \text{ft}^3$ of storage
add 10% safety factor $1800+180 = 1980\ \text{ft}^3$ of storage needed
or 14,810 gallons (1980x7.48)

$\frac{(40\text{x}45)+10\%}{1.25} = \frac{1980}{1.25} = 1584$ square feet of apron needed or
50' x 32' apron

2. Apron Construction. The following general instructions apply for all aprons:

a. Clear all vegetation and smooth the catchment area to flow to the center and lower end with a road grader or bulldozer.

b. Protect the apron from outside water and debris with a border 8 to 10 inches high. A small drainage ditch just outside the border may help.

c. Do not build apron or cistern where it will be damaged by trees, floods,or other hazards.

d. Slope the apron 2 to 5 percent to the lowest point.

e. Fence to keep out livestock.

f. Additional Instructions.

(1) Asphalt and Sand Aprons. Lay net wire over apron surface. Mix asphalt into an easy working mixture of about 30 gallons of

asphalt to 1 yard of damp sand. This is 30 percent more asphalt than would be used in paving. Do not use straight asphalt as it may creep in the sun's heat. Spread mixture with hand-pushed roller to about 2-inch thickness. Top dress the surface by spraying with asphalt. This differs from road topping as it does not need compression strength.

(2) Asphalt and Metal or Plastic Films. Asphalt is sprayed on the soil surface. A film is then unrolled in 4-foot wide strips from a spindle mounted just ahead of a foam rubber roller which presses the film against the soil. The U.S. Water Conservation Laboratory, Tempe, Arizona 85281, has more information on this method.

(3) Rubber Aprons. These are large sheets of rubber which are laid out on the ground. They are easily installed. One source is Watersaver Company, Inc., 3560 Wynkoop, Denver, Colorado 80216.

3. Cistern Construction

a. May be metal, concrete, rubber, or earth.

b. Earth tanks may be sealed by spraying the dry interior with asphaltic compounds or by lining with plastic sheets.

c. Rubber tanks, actually bags, may be obtained from the Firestone Tire and Rubber Company or Watersaver Company, Inc.

d. Open tanks should be covered, preferably with metal, to reduce evaporation.

350 - WELLS. There are two types of water wells, vertical and horizontal.

350.1 - Vertical Wells. These should be considered where there are no other water sources. They provide a reliable and permanent supply of water for stock use. The cost of drilling and equipping a well may compare favorably with the cost of constructing a stock pond. When properly completed, the well should last indefinitely. They can usually be drilled near the forage supply and provide a safer place than stock ponds for winter use by livestock.

There are several disadvantages, the most serious usually being the cost of drilling and failure to find water each time. Total installation costs, including storage tanks and troughs, are expensive.

Points to be considered when drilling a vertical well are:

1. Recommendations of a competent ground water geologist.

2. Efficiency, depth, and production of other wells nearby.

3. The amount of range the well will water; either at site or by piping or hauling water to other troughs.

4. The depth from which a windmill will pump. Check wheel size against depth with the mill manufacturer.

5. Automatic starting pump engines (gas or LP gas) have varying success and may need frequent checks. Use commercial power if possible.

6. Oil supply in the windmill head must be checked every three months.

7. A "weep" hole should always be drilled in the pipe to drain the water back below the frostline.

Usually, well drilling must be contracted. The services of an engineer and a contracting specialist should be obtained.

See FSM 2541.21 on water rights and State requirements for filing on wells before and after drilling.

350.2 - Horizontal Wells. In the simplest sense, a horizontal well is a "cased spring," and once developed it requires no power system to pump and dispense the water. Because the water is cased in a "closed system" from the point of origin to the point of use, it is more sanitary than almost any other range water. When the well is turned off, the ground will retain the water like a storage tank, and like a storage tank, the closed system could be drained if allowed to run and not caped.

1. Site Selection. Horizontal wells cannot be drilled just anywhere; site selection is most important.

Potential sites are located by evidence of a water seep, presence of water-loving plants, or observation and analysis of geologic formations. Generally, a site will show geological evidence of either a natural dike or "contact" type of spring.

The dike formation (see figure 1) is a geologically tilted impervious formation such as a rock which forms a natural barrier to an aquifer, in essence, a natural dam for an underground water storage reservoir. Water may not be visible, or it may seep through cracks in the dike or over the top of the barrier. The objective in horizontal well development of a dike formation is to drill through the barrier somewhere below the seep and tap the storage water.

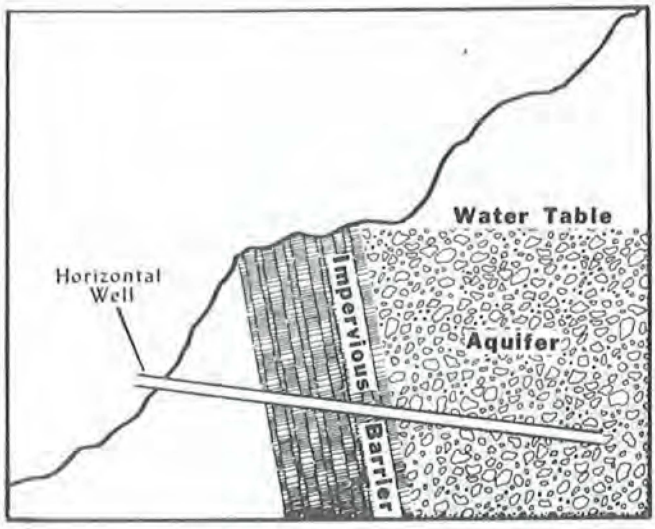



Figure 1
Dike Spring Formation

The contact type (see figure 2), consisting of a perched water table above an impervious material, is more difficult to recognize. Water seeps out at a point near the outcropping impervious layer. The line of seepage can frequently be located by observing the presence of water-loving plants. Drilling below the seepage will often fail to increase the yield because the entry may be into the impervious layer.

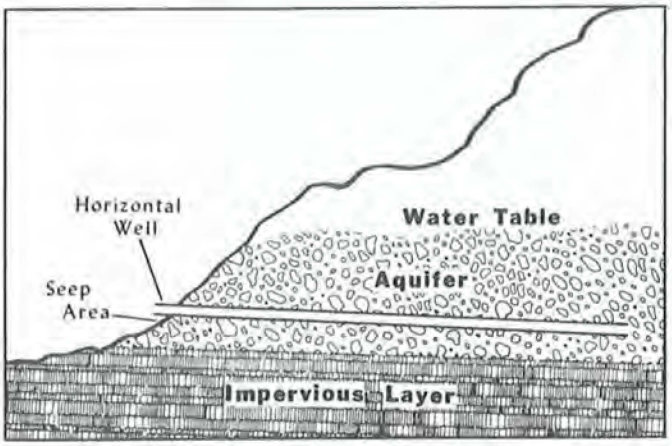



Figure 2
Contact Type
of Spring Formation

2. Drilling Equipment and Process

a. Drilling Equipment. The drilling machine essentially is a tubular subframe supporting two steel "I" beams approximately 10 feet long. A pipe chuck (drilling head) which holds the drill stem is powered by a 10 to 15 hp gas engine. The drilling head slides on the two "I" beams. The whole machine is mounted on two wheels so it can be pulled by a pickup truck. The machine is light and mobile enough that two people can move it about on flat ground. The machine can easily be broken down into three pieces which can be transported by helicopter to any location which is large enough to set the tubular frame down safely.

b. Drilling Process. Drilling is started at a likely site with a minimum downward slope of 4 percent. Water, pumped through the rotating drill stem, washes the cuttings back through the annular clearance between the hole and the stem. A portable gasoline engine-driven pump circulates water necessary to cool the bit and remove the cuttings. A continuous flow of return water is essential to prevent binding of the drill stem in the hole. Return flow is directed to a holding pond for settling and reuse.

With evidence of water production, the drill stem is removed and a 2-inch pipe casing is drilled in. When in place, a cement slurry is pumped in beside the casing until there is evidence of the return flow of the cement in the casing; it is then allowed to set overnight. The next day the drill stem is inserted in the casing and drilling continues until a satisfactory yield is produced or until a practical drilling limit has been reached. The drill stem is then replaced with 1¼-inch perforated pipe through the principal water-bearing strata to shore the hole.

The drilling rate usually varies from 3 to 9 inches per minute through heavy clay, decomposed granite, or soft rock. In extremely hard rock, the rate may be less than 1 inch per minute.

3. Plumbing. The plumbing for the system is simple, consisting of a gate valve, vacuum relief valve, and fittings, all attached to a tee at the end of the casing. If the relief valve is subject to fouling from dirt or debris, a riser is included. With the well at a downward slope into the aquifer, the tee and air relief valve are at the high point in the system and the vacuum relief valve prevents the formation of a vacuum in the casing when flow rate exceeds water yield from the formation. If the vacuum were permitted to exist, fine grained materials would be sucked from the water-bearing strata into the system.

The elevation of the water in the aquifer above the outlet provides a head of water making this a completely automatic water system. From the tee, the necessary distribution pipe is connected to the float-controlled watering sites.

4. Advantages. The horizontal well system has a number of advantages over other range water supply systems:

a. When compared with conventional springs, water loss is minimized since the flow can be controlled by float valve or completely shut off when not required.

b. The system provides a sanitary water supply. Normally spring water supplies are of good quality and purity as they emerge

from the ground. Contamination in a spring area is common and difficult to control. With the horizontal well, the possibility of contamination at this point is virtually eliminated. However, signs should be placed to warn the public the source is not potable water and may be contaminated.

c. The cost of a horizontal well will usually be substantially less than any other water supply except the natural spring.

d. Maintenance is low for the life of the water supply and operational costs are insignificant. The only working parts are a float valve, a check valve, and a shutoff valve.

360 - PIPELINES AND SIPHONS. The source of water supply for a pipeline or siphon must be permanent or dependable, and capable of providing the daily water requirements for the livestock served during the period the area is grazed.

360.1 - Pipelines

360.11 - Design of Pipelines

1. If a pipeline is over ¼ mile long, or if the pressure is 80 pounds per square inch or higher, it should be designed by a qualified engineer.

2. Pipe used for range water developments should not be smaller than 1¼-inch diameter. This size is large enough to prevent easy plugging by foreign material, and it will usually carry enough water for the smaller water systems.

3. The pipeline must be designed to comply with manufacturer's approved recommendations for the kind and size of pipe and must provide sufficient capacity, without exceeding the working pressure.

4. Adequate outlets, and provision for future expansion of the system, should be provided for in the design.

5. Air valves should be placed at all high points. Use gate valves whenever valves are used in the pipeline.

6. Provide for pipeline drainage in low spots to prevent damage through freezing.

7. Galvanized and plastic are the two main kinds of pipe used.

a. Galvanized. Galvanized pipe is not used extensively because of high cost, weight, and ease of bursting when water freezes. Galvanized pipe can be used when high water pressure, 200 PSI or higher, is needed and it is buried below frost line.

b. Plastic. Both polyvinyl chloride (PVC) and polyethylene (PE) plastic pipe are used in pipeline construction.

(1) PVC pipe is ordinarily used when working pressures are greater than 100 PSI and less then 200 PSI. PVC pipe is available in 21 foot semi rigid sections. It is susceptible to impact damage and breakage due to freezing. This pipe is light and easy to handle. Care must be taken when backfilling over PVC pipe.

(2) Polyethylene pipe usually comes in continuous rolls of 100, 300, and 500 feet, with working pressures of 80, 100, and 160 PSI. This pipe is pliable, can withstand some freezing of pipeline water, and is not highly susceptible to impact damage. Polyethylene pipe is easy to work with and light to handle.

8. The following formula can be used to: (1) calculate the pump pressure needed to lift water a certain height or (2) to determine the amount of pressure developed by water flowing through a pipe. This formula is based on the fact that 1 pound of pressure will lift water 2.31 feet. Pipe frictional losses are not figured into this formula.

$ft = 2.31 \times PSI$

When: ft = height or head of water in feet.
PSI = pressure in pounds per square inch.

Example 1: A pump is capable of delivering a pressure of 90 PSI. How high in feet will this pump deliver water?

$ft = 2.31 \times PSI$
Height in feet = $2.31 \times 90$
Water will be delivered to a height of 207.9 feet

Example 2: A pipeline water system drops a total of 200 vertical feet. What is the pressure at the lower end of the pipeline?

$ft = 2.31 \times PSI$ or $PSI = \frac{ft}{2.31}$

$PSI = \frac{200}{2.31}$

Pressure at lower end of pipeline = 86.58 PSI

## 360.12 - Installation of Pipeline

1. All metal or PVC pipe should be protected from damage by freezing. If necessary, make provision for completely draining the pipeline.

2. All plastic pipe should be covered.

3. Pipelines should be tested for leaks and left full of water when backfill is placed in trench.

4. Polyethylene and PVC pipe should be laid in the trench in a snakelike fashion to allow for contraction when filling it with water.

5. To prevent collapse, plastic pipeline should be filled with water before covering with soil. Be careful not to drop rocks on pipe when filling ditch.

6. PVC and polyethylene pipe should not be backfilled when air temperature exceeds 95 degrees F, or is less than 50 degrees F.

7. Backfill to 4 inches in depth with selected material without rocks over 6 inches in maximum dimension. In rock excavation, also place 4 inches of same select backfill bedding material under pipe. Backfill should be mounded to allow for settlement over pipeline.

8. All disturbed areas created by excavating for the pipeline should be seeded and mechanical dip structures used if necessary to control erosion.

9. If cattle begin to trail on a pipeline location, barricade the disturbed area with a cover such as cut sagebrush or tree branches.

10. There are two main ways of laying pipelines: (a) open ditch and (b) ripping.

a. Laying pipe in an open ditch or trench is the most common installation method. The trench is opened with a backhoe or ditcher. The use of a "V" ditching plow or the end of a grader blade has also been used extensively. This method works well for both rigid and flexible pipe.

b. Ripping pipelines into the ground is a fairly new technique. After the pipeline has been staked on the ground, a ripper tooth, like those used to rip rock for road construction, is pulled through the ground at the desired pipeline depth. Mounted 2 or 3

inches behind the ripper tooth is a hollow tube into which the pipeline is fed into the ground. The ripper tooth makes the trench and the hollow or feeder tube delivers the pipe into the soil. See exhibits 3 and 4. There is very little ground disturbance with this method and it is fast, up to two miles of pipe laid per hour.

Ripping is not well suited for rigid pipe but is used frequently with flexible pipe.

This method is not well suited for water lines having a critical gradient due to a slight wave motion in the line as it is ripped in.

The ripper tooth and feeder tube can be mounted on a crawler tractor or grader.

360.13 - Methods of Connecting Pipe

1. Treaded Sleeve. Use of a threaded sleeve is a common method of connecting pipe. One end of the pipe is threaded and attached to a threaded coupling. This method is used mainly for galvanized pipe and some PVC plastic pipe.

2. Gluing. A fast setting glue is applied to half the inside of a snug fitting sleeve which is placed half way over the end of a pipe and let set. Another piece of pipe is then glued and inserted into the remaining sleeve half. This method is used extensively with PVC plastic pipe but not with polyethene pipe.

3. Belled End Pipe. Each end of a pipe is designed with a bell shaped end with a rubber "O" ring inside the bell. When the regular end of the pipe is inserted into the bell, it becomes water tight and is held in place by the rubber "O" ring. This is sometimes used with PVC plastic pipe but not with polyethene pipe.

4. Nylon Insert and Stainless Steel Bands. A nylon insert is placed in the end of the pipe and a stainless steel band clamp is then tightened over the pipe to hold the pipe and insert in place. This connection is used extensively with polyethylene pipe but not with PVC pipe.

5. Heat Fusion. This method is more involved than will be explained here, but is essentially the heating of two ends of polyethylene pipe until they start to melt, then bonding the two ends together, forming a connection. Two pieces of special equipment are needed for proper heat fusion of plastic pipe. These are a double-jawed pipe vise and a two-faced heating plate.

Exhibit 3
Ripper tooth and feeder tube

Exhibit 4
Tractor and ripper tooth and feeder tube

360.2 - Siphons. A siphon is an inexpensive method by which water may be raised over an obstacle and moved from one area to another area of equal or lower elevation. At sea level, water can be raised 32.8 feet. The lift is lessened as the elevation above sea level rises. The siphon will give good continuous delivery during cool weather, but during warm weather the air in the water will separate, forming air pockets which cause the siphon to lose its prime.

Siphons must be installed only where frequent inspections of the installation can be made. They should not be relied upon to furnish a continuous and dependable water supply without frequent inspection.

Because of pipe friction, pipe smaller than 1¼ inches should not be used. Materials needed to build a siphon are:

1. Check valve. Place it at the end of pipe in source of water. When priming, the check valve will prevent water from running out into source.

2. Screen. Place screen at the end of pipe in water source to keep debris out of the pipe.

3. Water Container. Drain pipe and turn valve are attached to bottom of container. Connect container to pipeline at highest point in pipe. The container is used to hold water for priming purposes. The capacity of the containers depends on the size and length of pipe from container to water source plus some additional capacity for forward movement of water to start siphoning. Generally, a 20-gallon container is sufficient.

4. Pipe. Minimum size of pipe is 1¼ inches. The length of the pipeline depends to some extent on the drop. With considerable drop, the force of gravity may burst a line unless pressure release valves are used. With such installation, water may be piped long distances.

The line should be buried only when a permanent installation is desired. A temporary line need not be buried except at road crossing or where the pipe may be damaged.

Siphons may be used with various types of reservoirs or storage tanks to lead water to a watering tank or trough.

360.3 - Pumps Used With Pipelines. The most common type of pump used is electrical but water and gas driven pumps have been used.

1. Electrical. The two major types of electrical water pumps are submersible and jet. The jet pump is used mostly for home or ranch use and the submersible for home and ranch as well as field use.

Some submersible pumps have the capability of pushing water several hundred feet vertically.

2. Gas and Propane. Gas or propane driven pumps are good if electricity is not available. Because of the motor, these pumps have to be checked and serviced regularly. These motors can be set for selfstarting with a time clock or float.

3. Water. Water power can be used to pump water using a hydraulic ram or a water wheel.

a. Hydraulic Rams. A hydraulic ram is a device for pumping water by means of water power. It can be connected to a spring, tank, stream, or artesian well having an available flow of at least 1½ gallons per minute. The flow and fall of water does the pumping, and no outside source of power is required. Therefore, a hydraulic ram may be ideally suited to isolated locations having an ample water supply.

A fall of 20 inches or more between water supply and ram is necessary, but most rams are designed for a minimum vertical fall of 24 inches. It can automatically pump water to a height of 25 feet for each foot of fall available (example: 2 feet in fall will produce 50 feet in height).

The amount of water used for power by a hydraulic ram increases with increased vertical fall from water source to ram and also with increased lift from ram to storage tank. The percentage of the water, received in ram from source, which is delivered to storage tank varies from approximately 22.5 percent maximum to 1.5 percent minimum, depending upon installation.

Double acting rams may be installed when the source of water used for power differs from the source of water pumped into the storage tank; i.e., using stream or other water for power to pump spring water into storage tank.

Batteries of two or more rams may be used where it is desired to pump a large quantity of water and supply of source water is sufficient.

b. Water Wheel. A water wheel installed in a stream provides the power to run a vehicle transmission which in turn is connected to a water pump. A piston water pump is capable of fairly high pressure for pushing water.

## 370 - STORAGE TANKS AND TROUGHS

370.1 - Storage Tanks. These are used to supplement existing water facilities which do not provide an adequate reliable livestock water supply. Additional water storage will promote better distribution of livestock and flexibility in season of use in a grazing unit.

Minimum capacity should be adequate to provide sufficient water supply for livestock grazing the area served by the tank.

1. Open storage tanks in an extensive piping system are sometimes roofed to cut down evaporation losses and prevent pollution. Roofs of metal or wood may be used. Plastic coverings have not yet proven satisfactory.

2. Storage tanks are generally made of metal and can either have a metal or concrete bottom. The sides may be sections of metal plate or sheets of corrugated galvanized iron. Metal bottom tanks should not be set on concrete bases. Water condensation between the metal and concrete rusts the tank. A form filled with coarse sand provides a more suitable base.

Metal tanks of various sizes and descriptions are often available as military surplus.

3. Collapsible butyl rubber bags are also available. All the water collected can be held indefinitely without loss. Butyl bags are available in two types, one-piece and two-piece. The one-piece bag is built like a ballon, and can be set on the ground. One-piece bags do not store as much water as two-piece bags. Two-piece bags consist of two sheets of rubber. One sheet is laid in a dugout pit and the other sheet is laid over the pit. Water is stored between the two sheets. Fairly large quantities of water can be stored in these bags. Such bags are available up to 100,000-gallon capacity.

Some of these bags have been in use a number of years without apparent deterioration. The advantage of this type of storage is the ease of transportation and the minor cost of erection. Vulnerability to vandalism is an obvious disadvantage which can be partially overcome by placing the tank in a trench. Also, a major disadvantage is puncture damage by deer and antelope walking on them if not prevented from doing so with fencing or some other means.

370.12 - Common Types of Storage

1. Steel Rim With Concrete Base

Advantages -

a. Low maintenance and usually easy to repair.

b. Materials are commonly used and well understood.

c. The construction site requires little preparation.

Disadvantages -

a. The initial cost is relatively high when compared to some storage materials.

b. The materials are heavy and bulky which makes them difficult to transport to some locations.

c. Steel rim storages are easily and often damaged by vandals.

2. Concrete

Advantages -

a. Low maintenance and rarely damaged by vandals.

b. The construction site usually requires only limited preparation.

c. The materials are often available locally.

d. When properly installed, concrete has a long usable life.

Disadvantages -

a. The initial cost is usually highest of all storage materials.

b. Concrete storages most commonly have an open top which results in high evaporation losses.

3. Butyl Rubber

Advantages -

a. Easy to transport to most sites.

b. Lowest labor requirement of the storages reported.

c. To date, they have had little damage by vandals.

d. Closed surface resulting in no evaporation loss.

e. The 2-piece bag is relatively easy to repair.

Disadvantages -

a. Two-piece storage bags cannot be installed in shallow soils.

b. Water and snow on the storage cover may reduce the capacity.

c. Timely maintenance is necessary.

370.2 - Types of Troughs and Tanks

1. Metal Flume Troughs. This is a half-culvert type trough of smooth or corrugated galvanized iron available in a variety of lengths.

Advantages -

a. Variable lengths--short lengths may be assembled in the field.

b. Durable--not damaged by freezing.

Disadvantages -

a. Hard to keep level.

b. Limited storage capacity.

Construction Details -

a. Support and Framing. Spacing is generally 4 to 8 feet. There should always be poles or faming to keep animals from jumping over or getting into troughs.

b. Sizes. Half-culvert troughs come in several sizes. Two common widths are 29¼ and 25½ inches. Six-foot sections are easier to pack, otherwise 10-foot sections are best. Galvanized steel, 16 to 18 gage, is best. Be sure to specify open or closed ends and size of threaded flanges at inlet and outlet. Outlet should be ½ inch larger than needed to carry peak flow of supply line.

c. Leaks. A heavy coating of asphalt base paint or roofing cement will help prevent leaks. Corrosion holes can be repaired with hot asphalt saturated burlap, or canvas covered with extra coats of asphalt. Larger holes can be fixed with leather or rubber-locked washers bolted in place. These patches should be asphalt-paint covered.

d. Height. The edge of sheep troughs should be about 18 inches above the ground level and cattle troughs about 24 inches.

2. Metal Circular and Oval Tanks. This is an excellent design and is available assembled or in sections ready for assembly. Initial cost is high but it endures and maintenance is low. After a trough has been installed, there should be a 6-foot by 6- to 8-inch lift of gravel poured around the tank. This will prevent the ground around the tank from becoming a bog hole.

Steel or wood posts are set at intervals along the tank side. One-inch galvanized pipe or poles are attached to these posts with "U" bolts or nails for added strength and to keep stock out.

A simple inlet over the side of the tank with a line drain at ground level and a standpipe outlet with a reverse bend attachment is adequate. Sometimes a more sophisticated system of inlet and outlet pipes may be desired such as having both inlet and outlet pipes come through the bottom of the tank. This system will delay freeze up of the inlet and outlet pipes for a time and allow later fall use of the system.

a. Bottomless Type. Begin by placing a pin or stake at the center of the proposed tank site. Then scribe an arc where the edge of the tank will be, using a rope, wire, tape, or board the length of the tank radius. Level the area at least 2 feet beyond the edge of the tank. Dig a footing 4 inches deep where the tank edge will be. Place short pieces of reinforcing bar or bolts across the footing area and place the assembled tank over the footing, resting on the re-bar, with the top rim level. Place reinforcing mesh wire over the floor; pour concrete 4 inches deep over the floor of the tank and extending outward 2 or 3 feet from the edge of the tank. The bottom should have a 2 percent slope to the outlet drain.

b. Bottom Type. These tanks are built with a bottom made of the same material as the sides. They can be obtained in rectangular or round shape. A 2-inch lift of gravel should be put down and the tank placed on it. This will allow water to escape from under the trough. This will also prevent rapid rusting of the bottom of the metal troughs. The previous general instructions also apply to these

tanks. Two-by-ten lumber makes a good base for flat bottom tanks at temporary locations where water is hauled. The tank should be held in place with set posts. These tanks should be drained in the fall.

(1) Metal tanks are inexpensive and fairly maintenance free. They may rust out fairly fast if used on springs which have a high alkalinity content. Other kinds of tank material should be used if there is a high content of alkali. Engine covers, used to ship jet engines, are often available from military surplus and make excellent water troughs. They are made of heavy steel and in different sizes.

(2) Fiberglass tanks are commercially built and available in several sizes. They are a little expensive but are resistent to deterioration and are easy to transport and install. When ordering, particular attention should be given to the size of inlet and outlet pipe fittings.

(3) Redwood lumber or plank troughs should be used only when the supply of water will keep them full; otherwise, they check and warp. If kept full, plank troughs may last as long as metal.

Lumber or plank troughs are easily packed and can be mass produced at some convenient location to lower construction cost. Freezing does little or no damage. A plank trough development with plastic pipe is one of the most practical types at a steady flowing spring. Plumber's oakum is good for calking seams in wooden troughs. It is good practice to store a small supply in a can at the spring. An old shovel and a length of No. 9 wire left at a spring is handy for minor maintenance.

(4) Concrete troughs are expensive to construct and easily damaged by freezing. Under normal situations, these would not be used.

## 370.3 - Capacity of Tanks and Troughs

### CAPACITY OF ROUND TANKS WITH FLAT BOTTOMS

| Inside Diam. Feet | Gallons Per Ft. Depth | Capacities Rounded Off to Nearest Gallon Depth | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2' | 4' | 6' | 8' | 10' | 12' | 14' |
| 2'0" | 23.49 | 47 | 94 | 141 | 188 | 235 | 282 | 329 |
| 2'6" | 36.70 | 73 | 147 | 220 | 294 | 367 | 440 | 514 |
| 3'0" | 52.86 | 106 | 211 | 317 | 423 | 529 | 634 | 740 |
| 3'6" | 73.15 | 146 | 293 | 439 | 585 | 732 | 878 | 1,024 |
| 4'0" | 93.97 | 188 | 376 | 564 | 752 | 940 | 1,128 | 1,316 |
| 4'6" | 118.93 | 238 | 476 | 714 | 951 | 1,189 | 1,427 | 1,665 |
| 5'0" | 146.83 | 294 | 587 | 881 | 1,175 | 1,468 | 1,762 | 2,056 |
| 5'6" | 177.67 | 355 | 711 | 1,066 | 1,421 | 1,777 | 2,132 | 2,487 |
| 6'0" | 211.44 | 423 | 846 | 1,269 | 1,692 | 2,114 | 2,537 | 2,960 |
| 6'6" | 248.15 | 496 | 993 | 1,489 | 1,985 | 2,482 | 2,978 | 3,474 |
| 7'0" | 287.80 | 576 | 1,151 | 1,727 | 2,302 | 2,878 | 3,454 | 4,029 |
| 7'6" | 330.38 | 661 | 1,322 | 1,982 | 2,643 | 3,304 | 3,965 | 4,625 |
| 8'0" | 375.90 | 752 | 1,504 | 2,255 | 3,007 | 3,759 | 4,511 | 5,263 |
| 8'6" | 424.36 | 849 | 1,697 | 2,546 | 3,395 | 4,244 | 5,092 | 5,941 |
| 9'0" | 475.80 | 952 | 1,903 | 2,855 | 3,806 | 4,758 | 5,710 | 6,661 |
| 9'6" | 530.18 | 1,060 | 2,121 | 3,181 | 4,241 | 5,302 | 6,362 | 7,423 |
| 10'0" | 587.47 | 1,175 | 2,350 | 3,525 | 4,700 | 5,875 | 7,050 | 8,225 |
| 10'6" | 653.69 | 1,307 | 2,615 | 3,922 | 5,230 | 6,537 | 7,844 | 9,152 |
| 11'0" | 710.69 | 1,421 | 2,843 | 4,264 | 5,686 | 7,107 | 8,528 | 9,950 |
| 11'6" | 776.77 | 1,536 | 3,107 | 4,661 | 6,214 | 7,768 | 9,321 | 10,875 |
| 12'0" | 848.18 | 1,696 | 3,393 | 5,089 | 6,785 | 8,482 | 10,178 | 11,875 |
| 12'6" | 917.73 | 1,835 | 3,671 | 5,506 | 7,342 | 9,177 | 11,013 | 12,848 |
| 13'0" | 992.62 | 1,985 | 3,970 | 5,956 | 7,941 | 9,926 | 11,911 | 13,897 |
| 13'6" | 1070.45 | 2,141 | 4,282 | 6,423 | 8,564 | 10,704 | 12,845 | 14,986 |
| 14'0" | 1151.21 | 2,302 | 4,605 | 6,907 | 9,210 | 11,512 | 13,815 | 16,117 |

### CAPACITY OF RECTANGULAR TROUGHS

| Width Ft. | Height Ft. | Length Ft. | Gallons |
|---|---|---|---|
| 2 | 2 | 4 | 95 |
| 2 | 2 | 5 | 120 |
| 2 | 2 | 6 | 140 |
| 2 | 2 | 7 | 186 |
| 2 | 2 | 8 | 195 |
| 2.5 | 2 | 8 | 250 |

## 370.4 - Specifications for Concrete Work

1. Cement. Cement should be delivered in the original packages and kept dry until used.

2. Sand. Sand for concrete should pass a No. 4 sieve, and at least 10 percent should be retained on a No. 10 sieve. Sand for mortar should pass a No. 8 sieve and at least 5 percent should be retained on a No. 16 sieve.

3. Aggregate. Aggregate for concrete should be clean, hard gravel or broken stone that will be retained on a 1/4-inch sieve and should be well graded in size from fine to coarse. Sizes specified for aggregate are the maximum acceptable and represent standard sieve sizes. By weight, 15 percent will be allowed in the following sizes: 1/2 inch, 3/4 inch, 1 inch, 1-1/2 inch, 2 inches, and 3 inches and not to exceed 10 percent of sizes under 1/2 inch.

4. Water. Water should be fresh, clean, and free from alkali and other foreign matter.

5. Proportions. Proportion dry ingredients by volume in the following ratio:

Cement: 3 parts
Sand: 5 parts
Coarse aggregate: 7 parts

Add water to obtain a slump of 3-6 inches. Based on the ratio of dry ingredients of 3-5-7, the water will be approximately 2 parts. Measure cement, sand, gravel, and water.

6. Mixing. No frozen, lumpy, or caked material should be used. No mortar of concrete should be retempered for use. Mixing tools and apparatus should be kept clean. Mechanical mixing is required by machine or by hand. Thoroughly mix until stones and pebbles are completely coated with sand and cement.

7. Protection from Cold. No concrete work should be done in freezing weather unless suitable means are used to heat the materials before placing and to protect the concrete after placing so that no damage from frost or freezing should occur. Protection after placing should include the use of temporary heat and covering if necessary. No antifreezing ingredient should be mixed with concrete. If weather conditions warrant, heat or protect concrete to maintain a temperature of more than $35^{o}$ F. for at least 24 hours after placing.

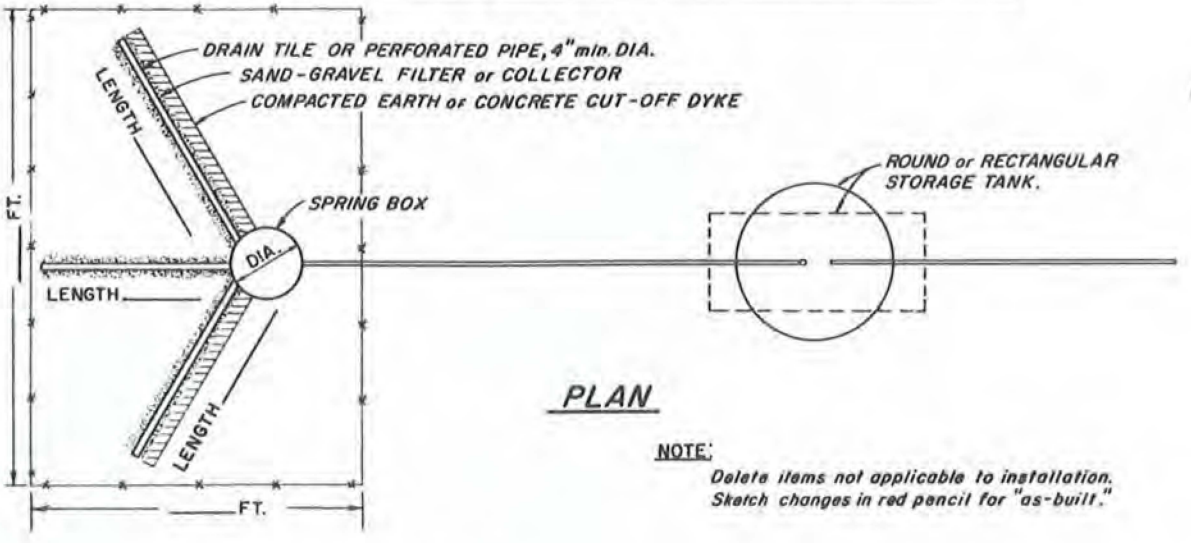
8. Forms. Forms should be tight and rigid to sustain the concrete without leakage or distortions and should be clean inside, free from frost, ice, mud, and water when the concrete is poured. Forms should be left in place until the concrete is safely self-supporting and should be removed without damage to the concrete.

9. Placing. Concrete should be so handled to maintain proper consistency and not permit the ingredients to separate. It should be placed immediately after mixing and be rodded, tamped, or worked into place so that voids or segregation of the aggregate should not show when the forms are removed. Place in layers to avoid segregation. Begin placing at corners of structure. Thoroughly dampen compacted subgrade before placement. Construction joints should be avoided.

10. Curing. Concrete should be protected against rapid drying. Keep surfaces moist a minimum of 2 days. Acceptable methods include ponding, wet burlap, wet straw or hay, curing paper, plastic sheets, and membrane curing compound.

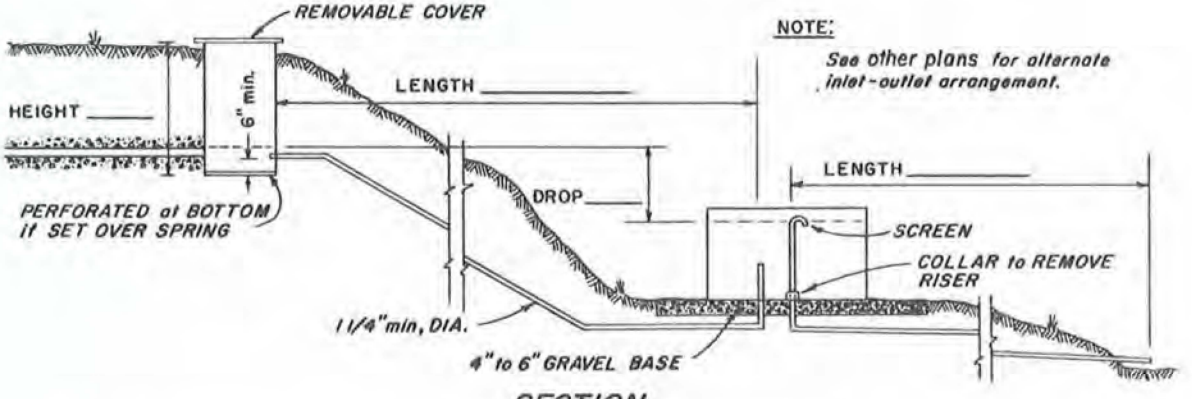
## 390 - STRUCTURAL PLANS

# SPRING and SEEP DEVELOPMENT PLAN




PLAN

NOTE:
*Delete items not applicable to installation.*
*Sketch changes in red pencil for "as-built."*




NOTE:
*See other plans for alternate inlet-outlet arrangement.*

SECTION

TANK: PLAN NO. _____ SHAPE _____ GALLONS _____
SPRING BOX: PLAN NO. _____
COLLECTION SYSTEM: PLAN NO. _____
SUPPLY PIPE: DIAMETER ____ LENGTH ____ TYPE _____ (MIN. 80 P.S.I.)
DRAIN PIPE: DIAMETER ____ LENGTH ____ TYPE _____
FITTINGS: _____

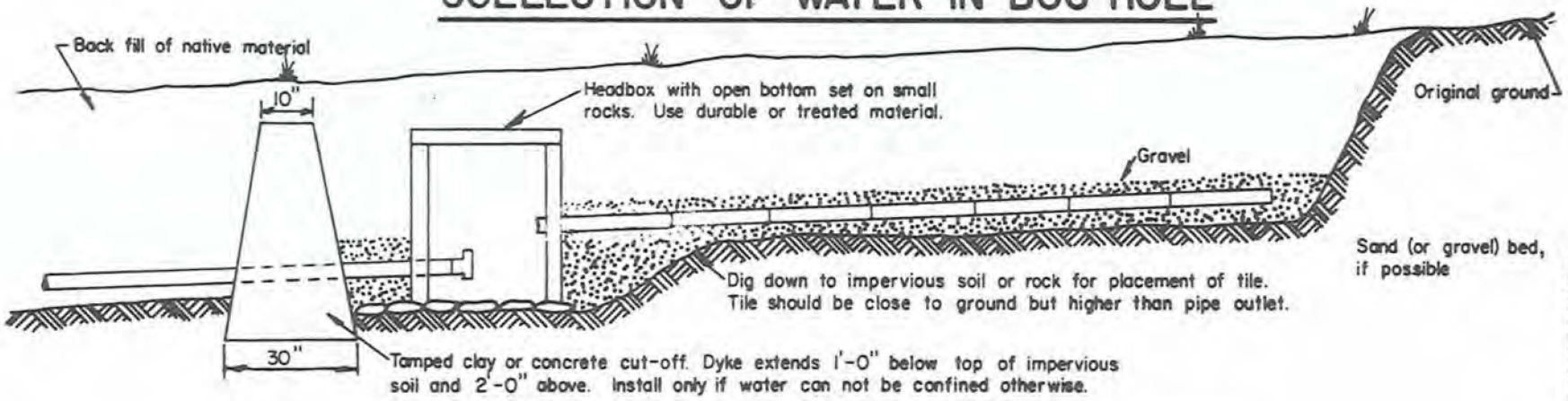
FENCE: FEET _____, PLAN NO. _____
NO. POSTS _____ TYPE _____ ROLLS WIRE _____
EXCAVATION, CU. FT. HAND _____ MACHINE _____
GRAVEL, CU. YD. _____ CONCRETE _____
REINFORCING STEEL _____
OTHER: _____

SPRING NAME _____
ALLOTMENT _____
LOCATION _____
PERMITEE _____
IDENT. NO. _____
PLANNED BY _____
DATE _____
CHECKED BY _____
DATE _____
INSTALLED BY _____
DATE _____
INSPECTED BY _____
DATE _____
COST _____

NOTE: FILL IN QUANTITY, LENGTH, SIZE, AND TYPE OF MATERIALS NEEDED. REFER TO CHAPTER 300 STRUCTURAL RANGE IMPROVEMENT HANDBOOK, FSH 2209.22 R1. SKETCH LOCATION ON BACK AND SHOW BEST ACCESS AND MILEAGE. INDICATE IF THERE IS VEHICLE OR OTHER ACCESS FOR CONSTRUCTION. ATTACH APPLICABLE DETAIL PLANS FROM CHAPTER 300, FSH 2209.22 R1.

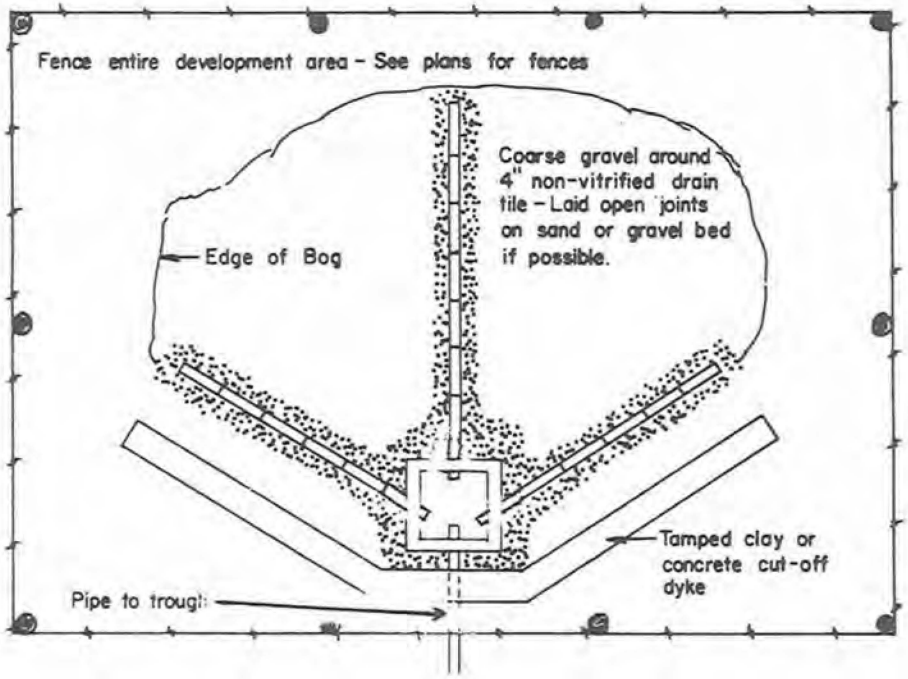
PLAN 320-1

# SPRING DEVELOPMENT
# COLLECTION OF WATER IN BOG HOLE

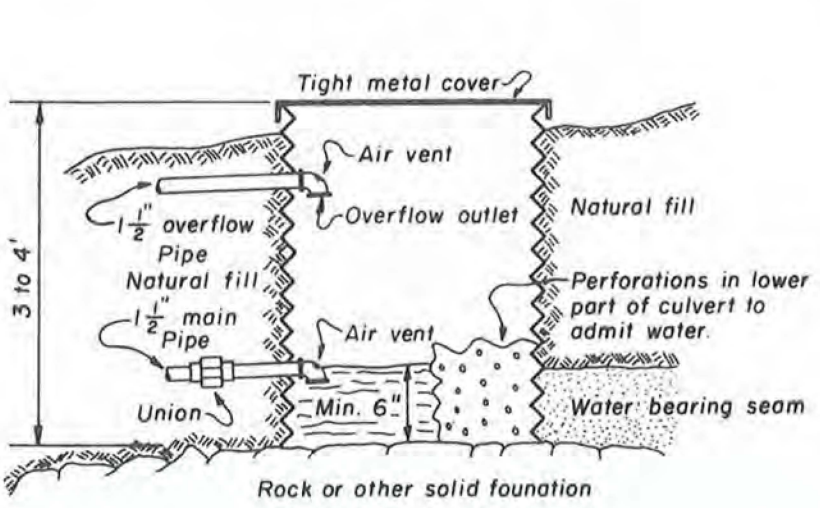

Back fill of native material
10"
Headbox with open bottom set on small rocks. Use durable or treated material.
Original ground
Gravel
Sand (or gravel) bed, if possible
Dig down to impervious soil or rock for placement of tile. Tile should be close to ground but higher than pipe outlet.
30"
Tamped clay or concrete cut-off. Dyke extends 1'-0" below top of impervious soil and 2'-0" above. Install only if water can not be confined otherwise.

HEADBOX

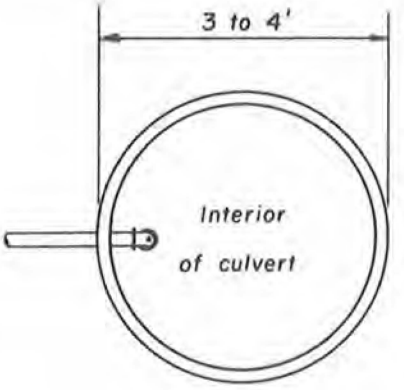
Plan dimensions = 3'-4'
Elevation = 3'-4'


Fence entire development area - See plans for fences
Coarse gravel around 4" non-vitrified drain tile - Laid open joints on sand or gravel bed if possible.
Edge of Bog
Tamped clay or concrete cut-off dyke
Pipe to trough

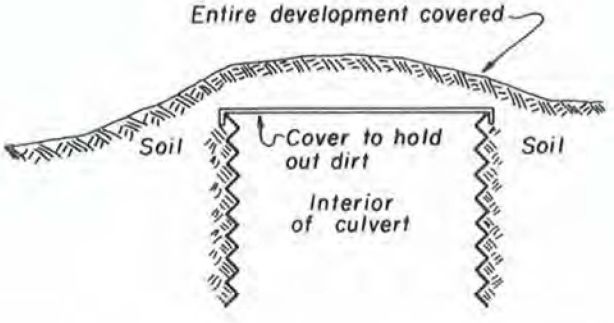
PLAN 320-2

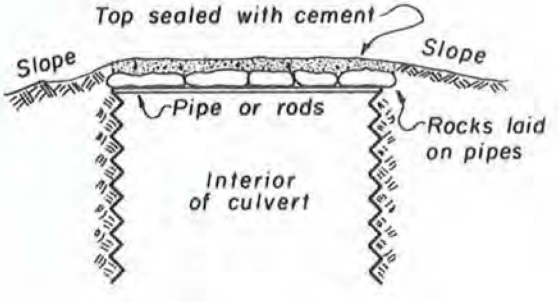



SECTION




PLAN

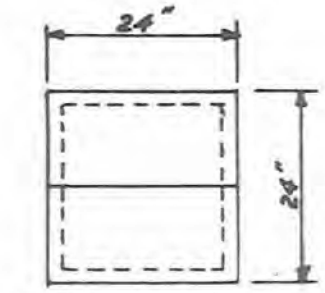


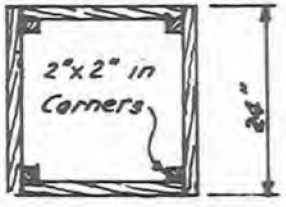

ALTERNATE METHODS FOR COVERING HEADWORKS

SPRING DEVELOPMENT
CULVERT HEADWORKS

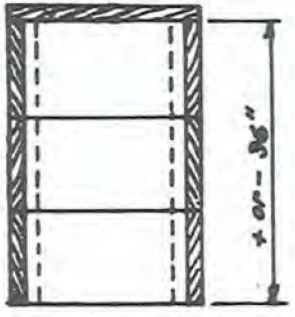
PLAN 320-3




TOP WITH COVER

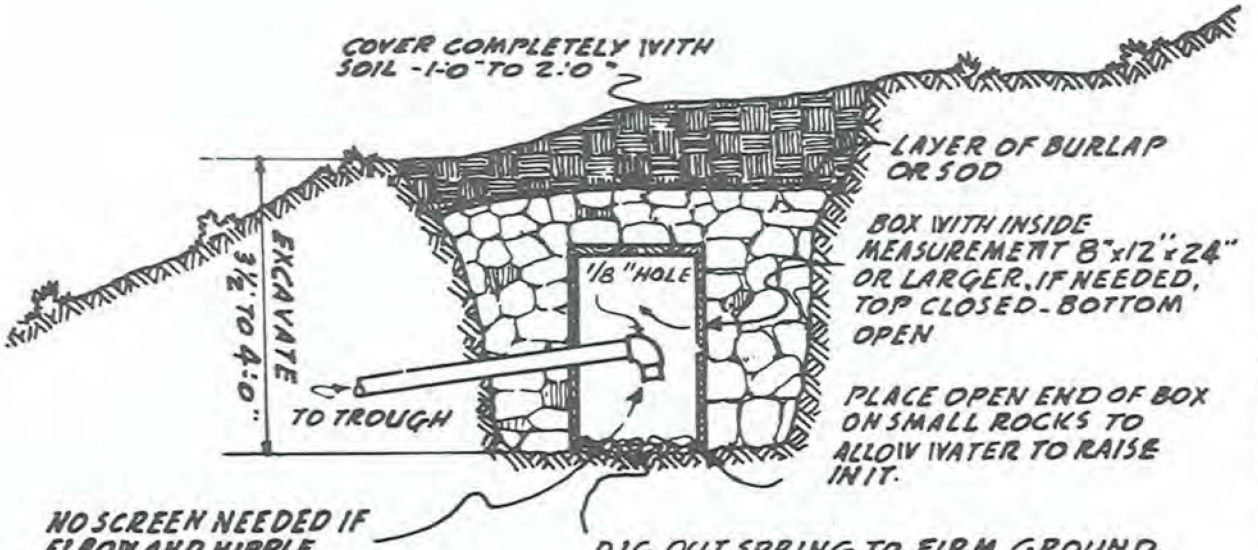



TOP VIEW




SIDE VIEW

PREFABRICATED HEAD BOX

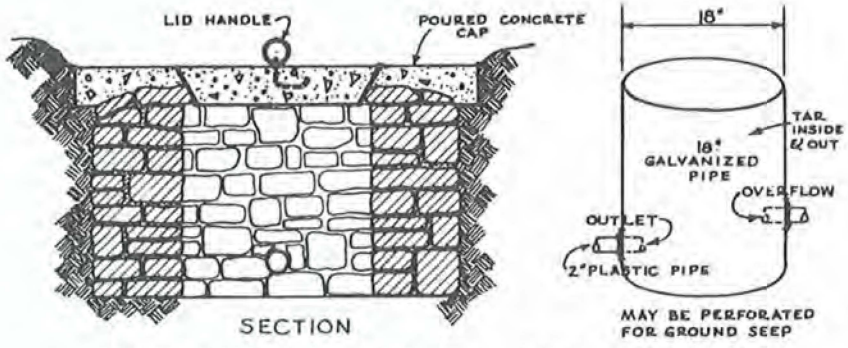

COVER COMPLETELY WITH SOIL - 1'-0" TO 2'-0"
LAYER OF BURLAP OR SOD
BOX WITH INSIDE MEASUREMENT 8"x12"x24" OR LARGER, IF NEEDED, TOP CLOSED - BOTTOM OPEN
1/8 "HOLE
EXCAVATE 3'-0" TO 4'-0"
TO TROUGH
PLACE OPEN END OF BOX ON SMALL ROCKS TO ALLOW WATER TO RAISE IN IT.
NO SCREEN NEEDED IF ELBOW AND NIPPLE ARE USED
DIG OUT SPRING TO FIRM GROUND, HARDPAN, OR ROCKS

CROSS SECTION

Note: Other material such a as washing machine or galvanized barrel may be used instead of wood. Wooden box should be durable material or ortho treated.

SPRING DEVELOPMENT.
BOX HEADWORKS
PLAN 320-4

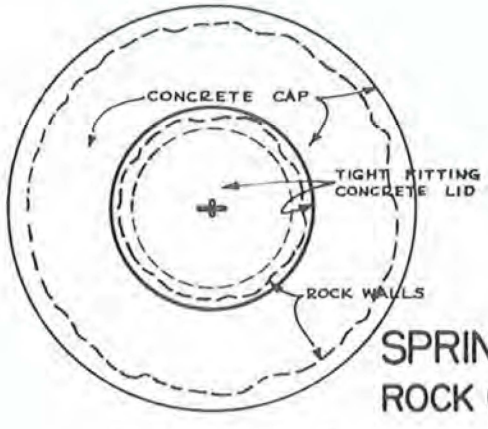
# ROCK CRIB OR GALVANIZED PIPE HEAD-BOX AND LID




18"GALVANIZED CORRUGATED METAL PIPE BOX OR ROCK CRIB

LID HANDLE EYE BOLT WITH RING
DISHPAN LINED WITH PAPER. POUR CONCRETE TO LEVEL OF TOP SLAB. WHEN CONCRETE IS SET, REMOVE DISHPAN.

DETAIL OF CONCRETE LID FORMED WITH METAL DISHPAN



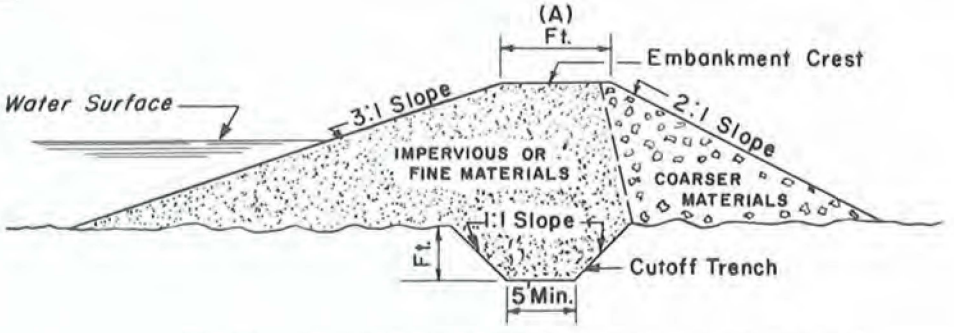

PLAN OF TOP

## SPRING DEVELOPMENT ROCK OR PIPE HEAD BOX

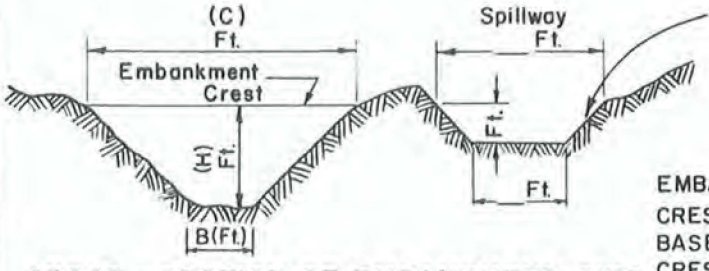
PLAN 320-5

STRUCTURAL RANGE IMPROVEMENT HANDBOOK

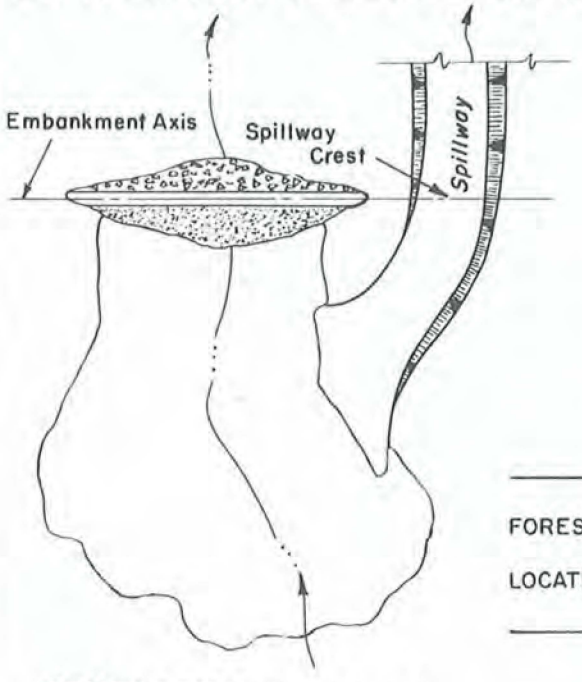
# STOCKWATER EMBANKMENTS




MAXIMUM CROSS-SECTION OF EMBANKMENT




CROSS-SECTION OF EMBANKMENT SITE




DEVELOPMENT LAYOUT

## EMBANKMENT

EMBANKMENT HEIGHT (H) _____ FT.
CREST WIDTH (A) _____ FT.
BASE LENGTH (B) _____ FT.
CREST LENGTH (C) _____ FT.
VOLUME _____ CU. YDS.
RESERVOIR CAPACITY _____ A.F.

## WATERSHED

DRAINAGE AREA _____ ACRES
AVERAGE ELEVATION _____
AVERAGE SLOPE (%) _____
SOIL TEXTURE

_____

TYPE AND DENSITY OF COVER

_____

SURFACE STORAGE

_____

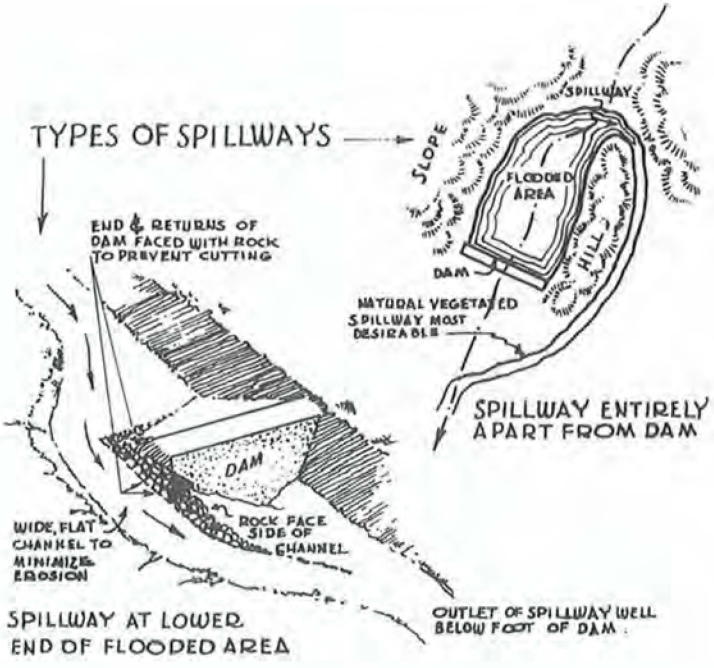
_____ STOCK WATER POND

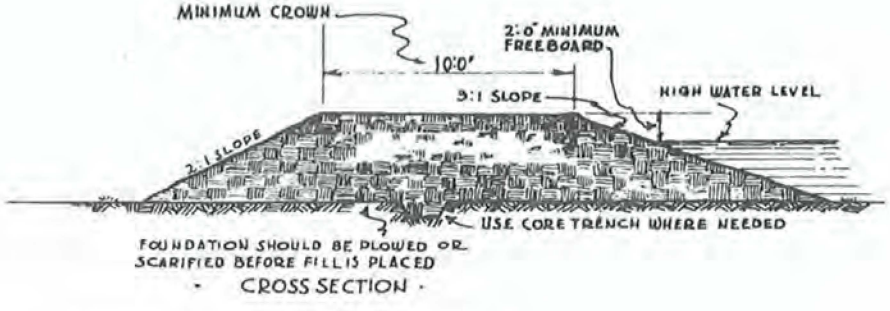
FOREST INVENTORY NO. _____

LOCATION-SEC. ____ TWP. ____ RANGE _____

_____ NAT'L FOREST _____ STATE

PLAN 330-1


TYPES OF SPILLWAYS
END & RETURNS OF DAM FACED WITH ROCK TO PREVENT CUTTING
SLOPE
SPILLWAY
FLOODED AREA
HILL
DAM
NATURAL VEGETATED SPILLWAY MOST DESIRABLE
SPILLWAY ENTIRELY APART FROM DAM
DAM
ROCK FACE SIDE OF CHANNEL
WIDE, FLAT CHANNEL TO MINIMIZE EROSION
SPILLWAY AT LOWER END OF FLOODED AREA
OUTLET OF SPILLWAY WELL BELOW FOOT OF DAM.

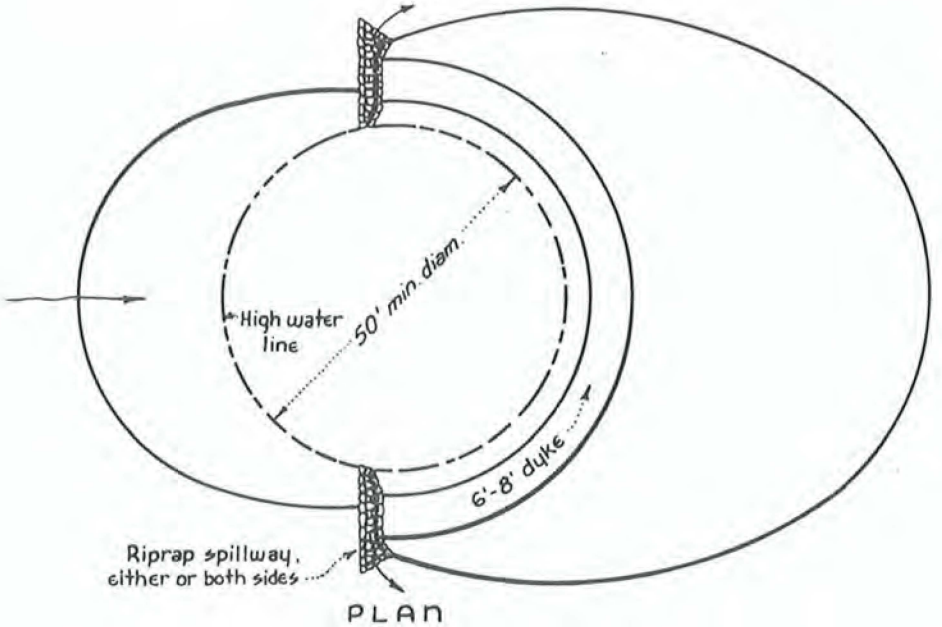



LIMIT CONSTRUCTION TO 6'0" HIGH OR 10 ACRE FEET STORAGE - EXCEEDING EITHER REQUIRES ENGINEERING DESIGN AND REGIONAL OFFICE APPROVAL.

DO NOT PUT IN LIVE STREAM CHANNELS

## DAM & RESERVOIR
## EARTH FILL

PLAN 330-2



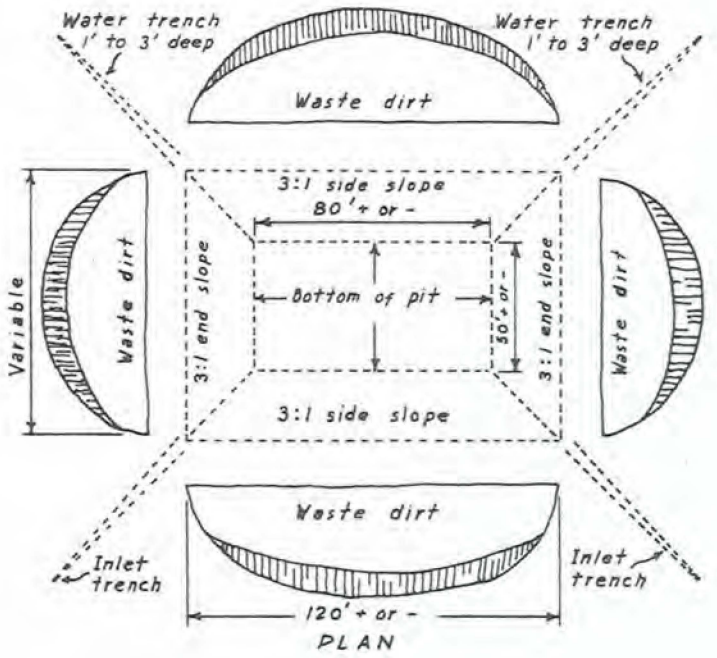

PLAN

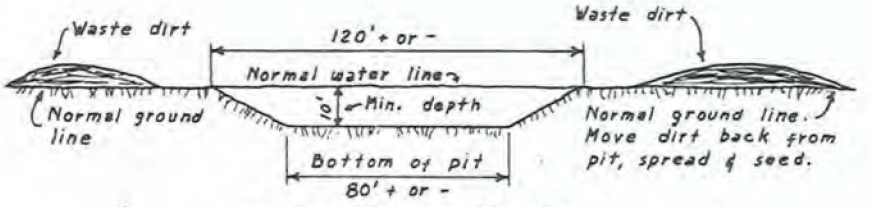
CROSS - SECTION

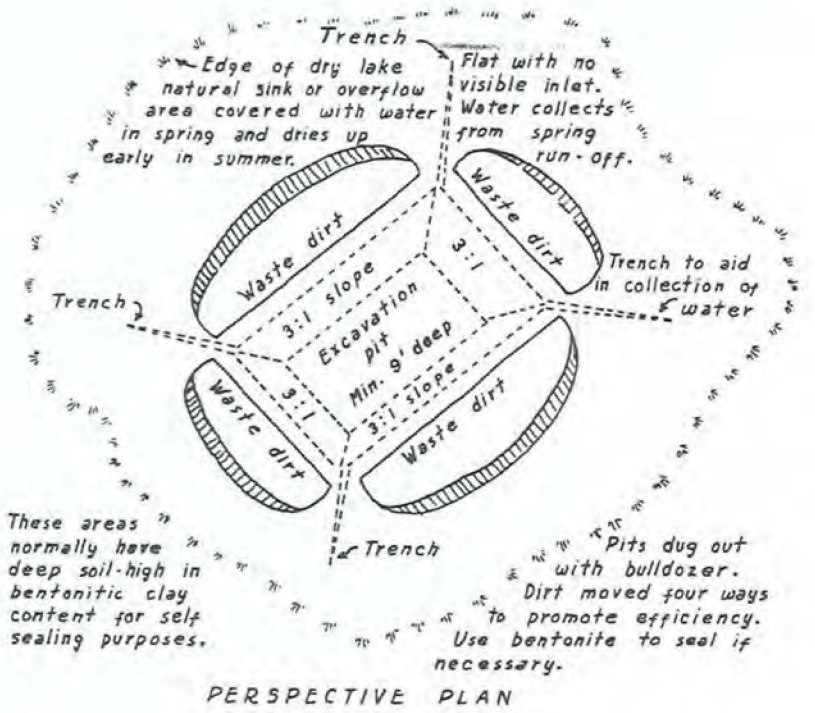
NOTE:
Coat with Bentonite.

## DAM & RESERVOIR
## EXCAVATED- EARTH FILL

PLAN 330-3

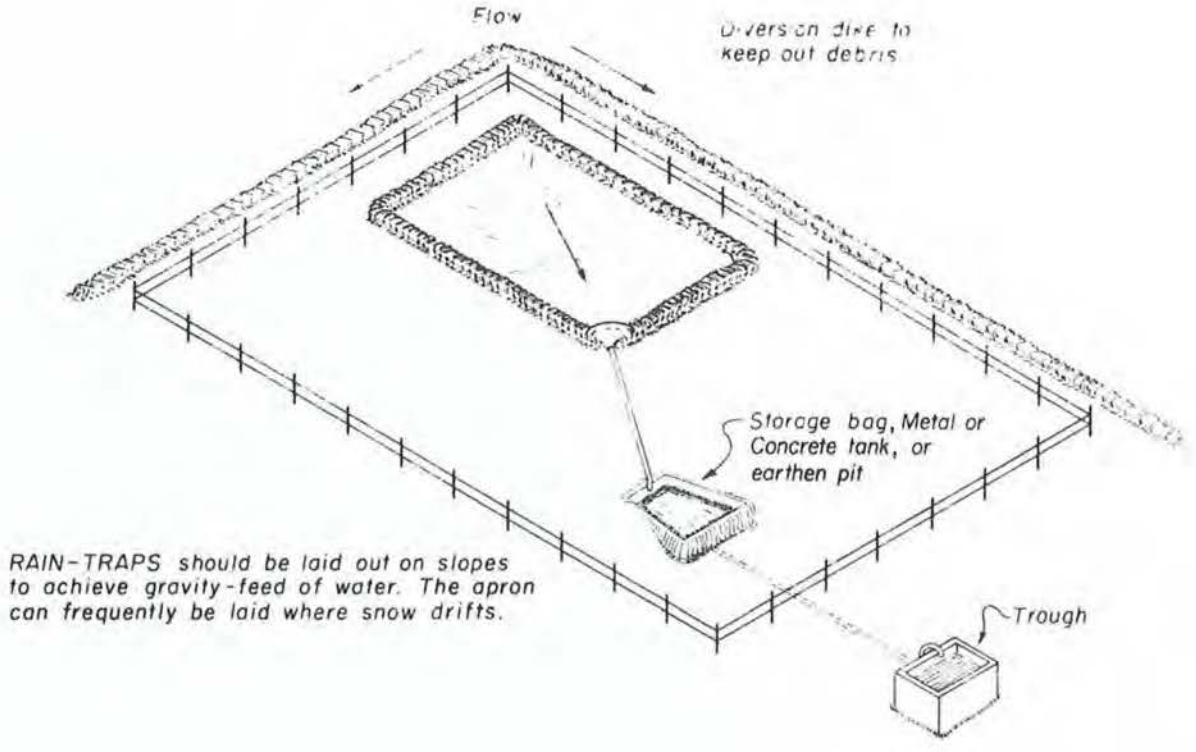


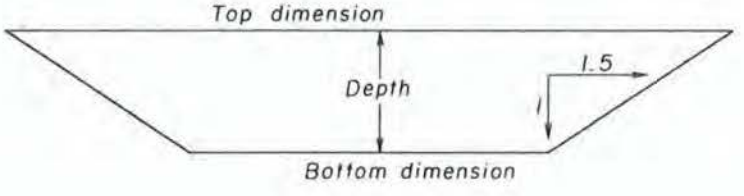


Trench
Edge of dry lake natural sink or overflow area covered with water in spring and dries up early in summer.
Flat with no visible inlet. Water collects from spring run-off.
Waste dirt
Waste dirt
3:1
Trench to aid in collection of water
Trench
3:1 slope
Excavation pit
Min. 9' deep
3:1 slope
3:1
Waste dirt
Waste dirt
These areas normally have deep soil-high in bentonitic clay content for self sealing purposes.
Trench
Pits dug out with bulldozer. Dirt moved four ways to promote efficiency. Use bentonite to seal if necessary.
PERSPECTIVE PLAN

## PIT TANK

PLAN 330-4


Flow
Diversion dike to keep out debris
Storage bag, Metal or Concrete tank, or earthen pit
Trough
RAIN-TRAPS should be laid out on slopes to achieve gravity-feed of water. The apron can frequently be laid where snow drifts.

*CROSS SECTION OF PIT EXCAVATION FOR BUTYL RAIN TRAP BAG*

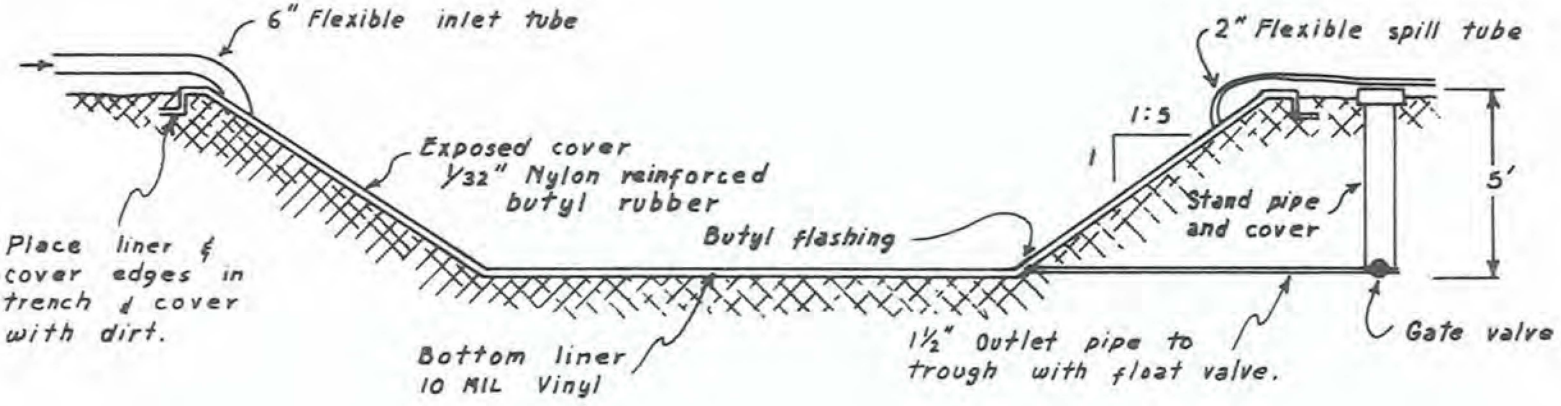



*DIMENSION OF PIT EXCAVATION*

| SIZE | TOP DIMENSION | DEPTH | BOTTOM DIMENSION |
|---|---|---|---|
| 25,000 gallons | 35' X 35' | 4.8' | 19' X 19' |
| 15,000 gallons | 29' X 29' | 4.0' | 17' X 17' |
| 5,000 gallons | 20' X 20' | 3.0' | 11' X 11' |
| 1,600 gallons | 8' X 10' | 1.8' | 3' X 5' |

TRICK TANK LAYOUT

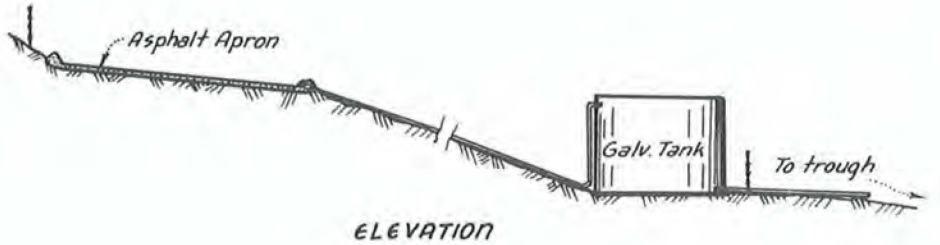
PLAN 340-1



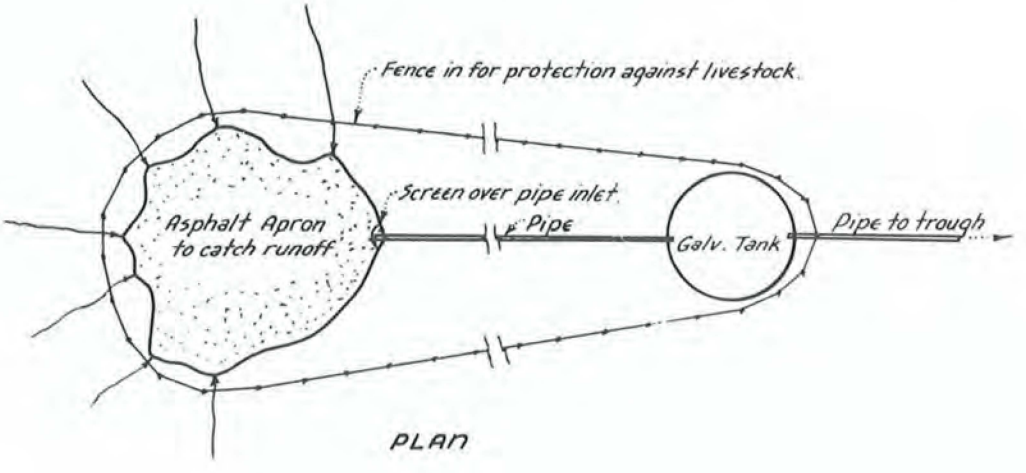

Pit is dug to specified size, smoothed and covered with heavy liner. Over this is laid the exposed cover of 1/32" Nylon reinforced Butyl rubber. Edges of both the bottom liner and top cover are folded into pit and covered with dirt to form an "envelope." Water entering this envelope separates the exposed cover from liner bottom. A 40,000 gallon pit will be 39' x 40' x 5' deep with 1.5 : 1 side slopes.

**STORAGE PIT**

PLAN 340-1a




ELEVATION

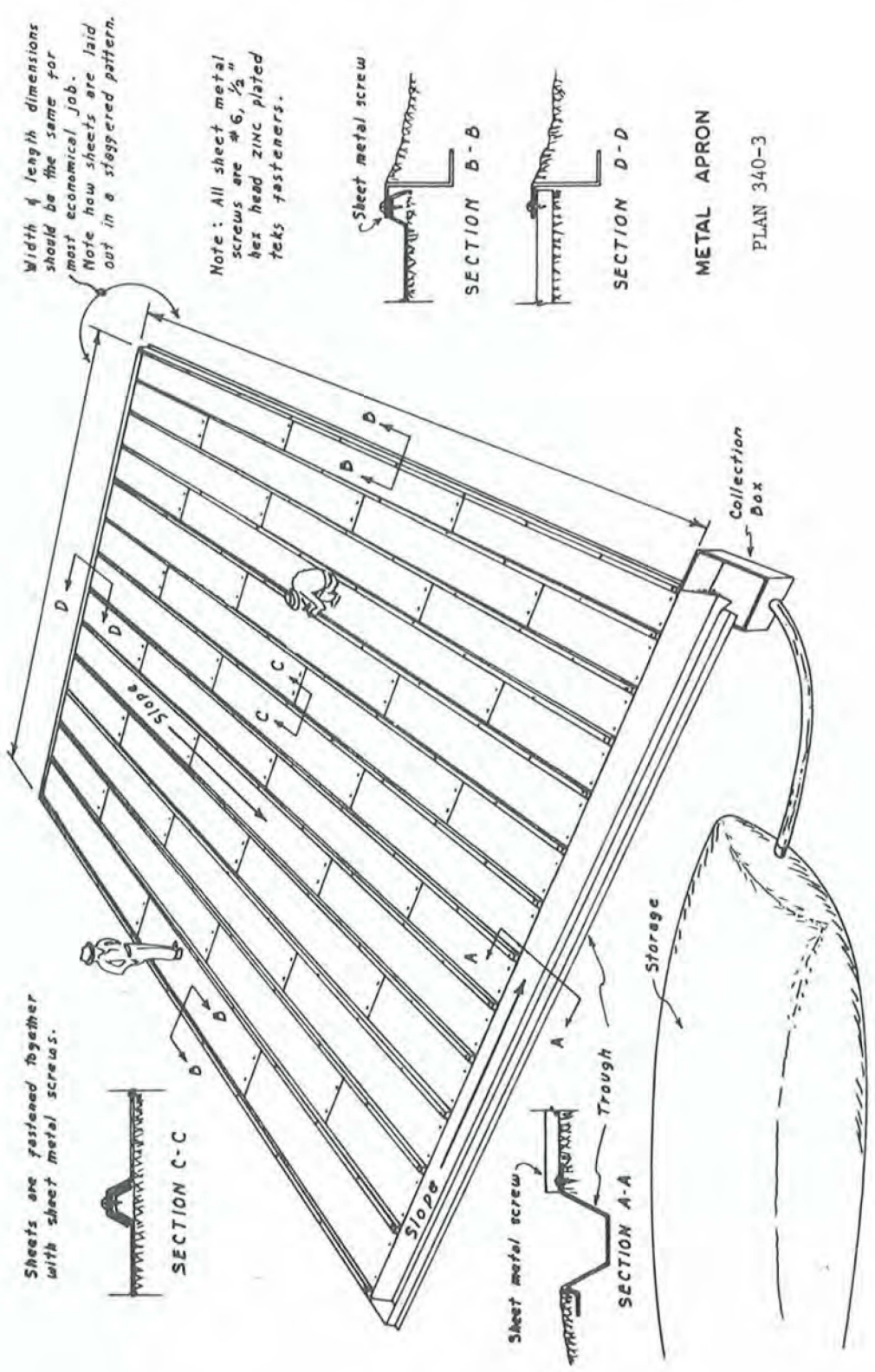



PLAN

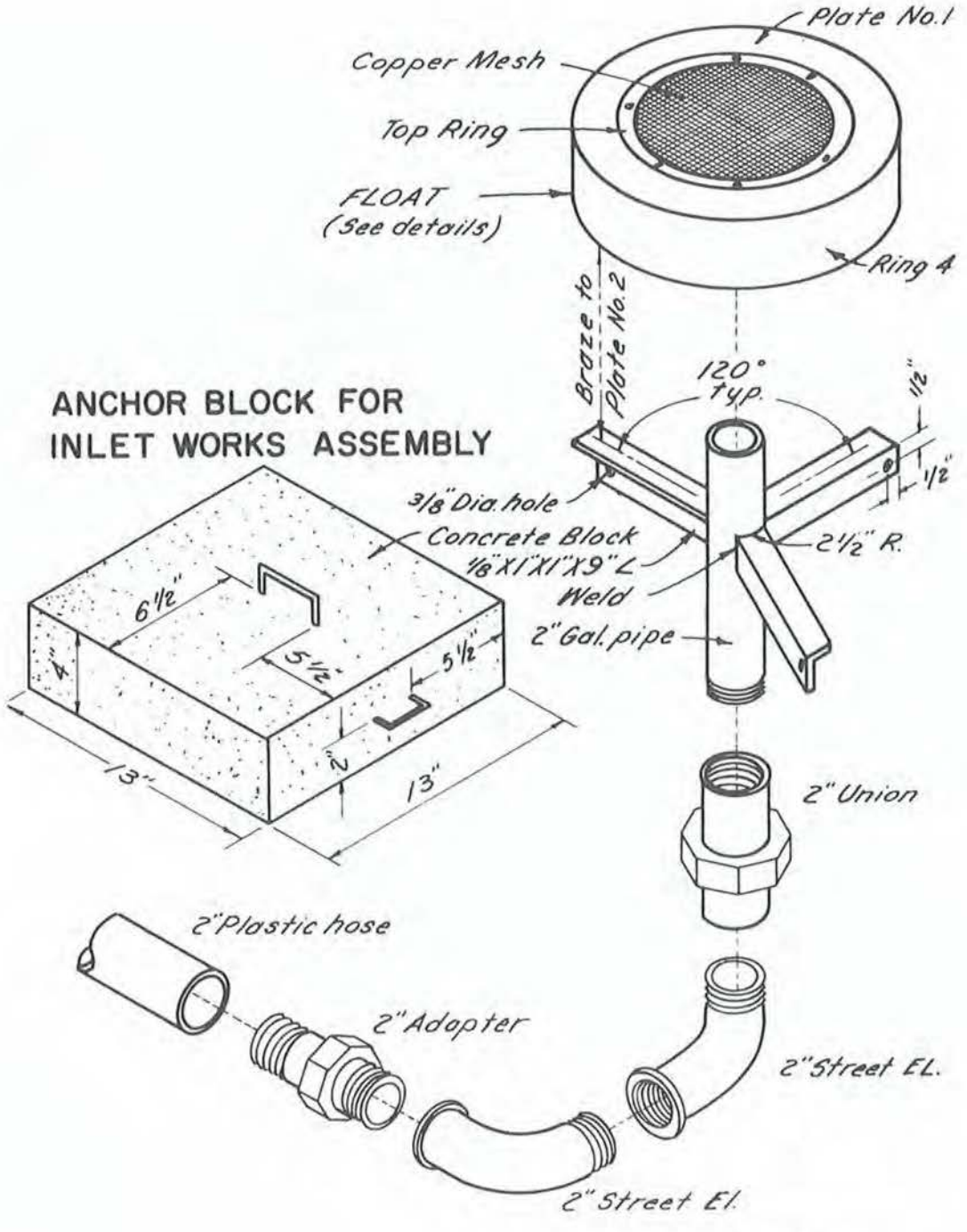
NOTE: Example for size of tank -
5,000 cow days
x 12 gallons water per day
60,000 gallons water

**TRICK TANK**
ASPHALT APRON

PLAN 340-2

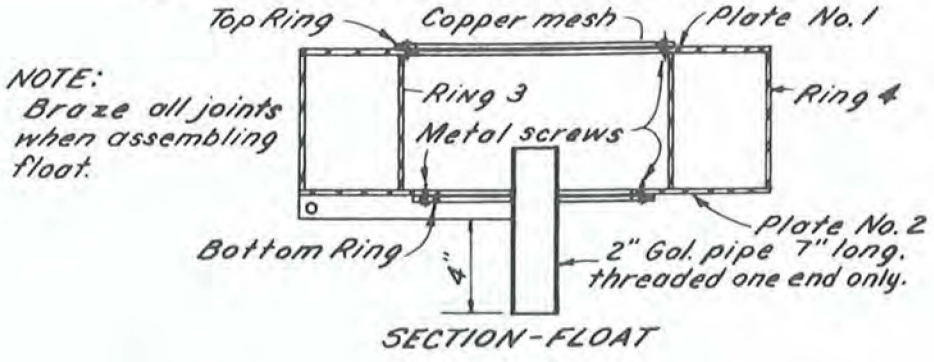

Width & length dimensions should be the same for most economical job. Note how sheets are laid out in a staggered pattern.
Note : All sheet metal screws are #6, ½" hex head ZINC plated teks fasteners.
Sheet metal screw
SECTION B-B
SECTION D-D
METAL APRON
PLAN 340-3
Collection Box
Slope
Storage
Trough
Sheet metal screw
SECTION A-A
Sheets are fastened together with sheet metal screws.
SECTION C-C

# STOCKWATER RESERVOIR INLET WORKS




PLAN 360-1

# DETAILS FOR RESERVOIR INLET FLOAT




SECTION-FLOAT

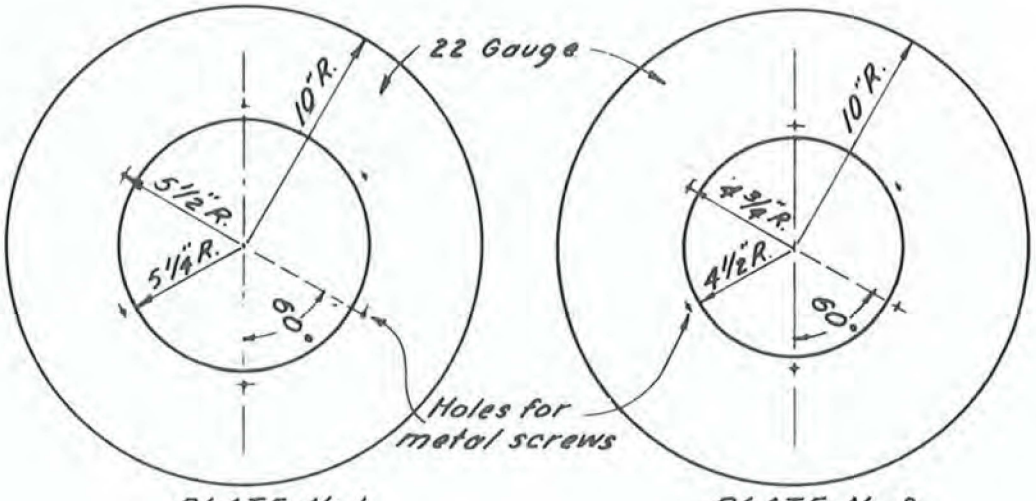
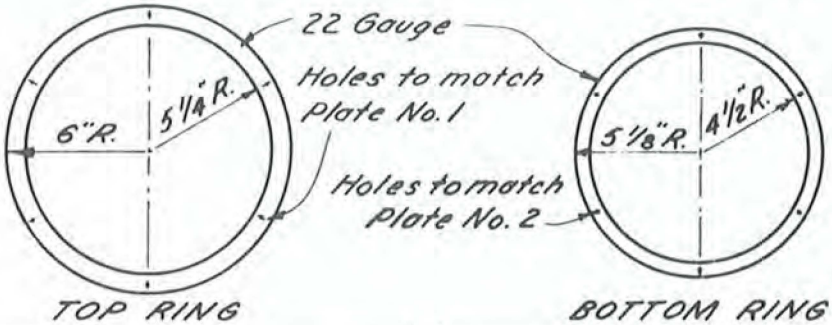
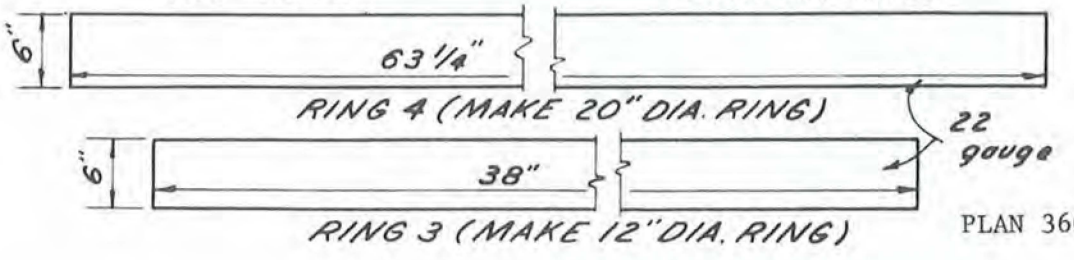



PLATE No. 1 PLATE No. 2



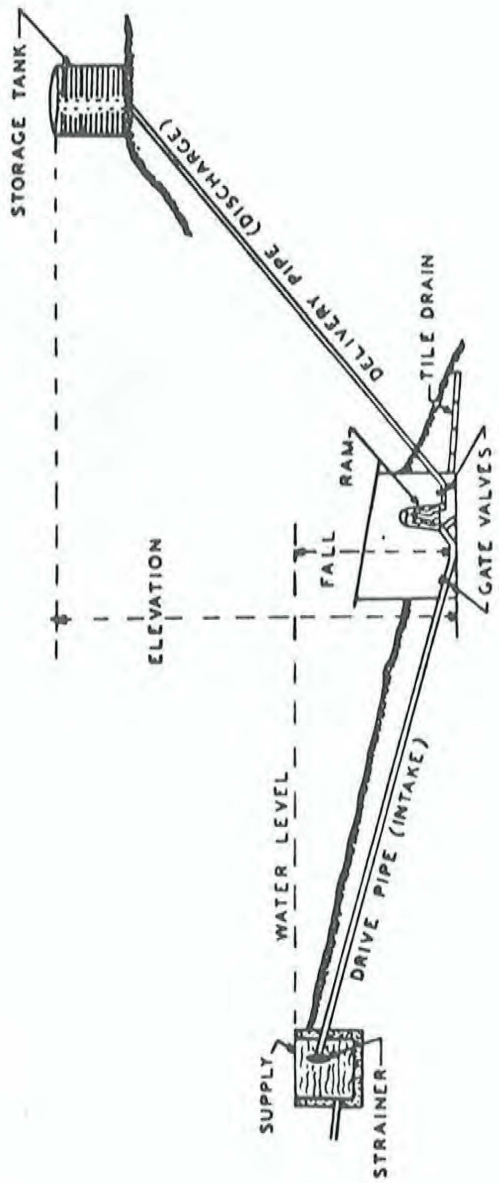

TOP RING BOTTOM RING

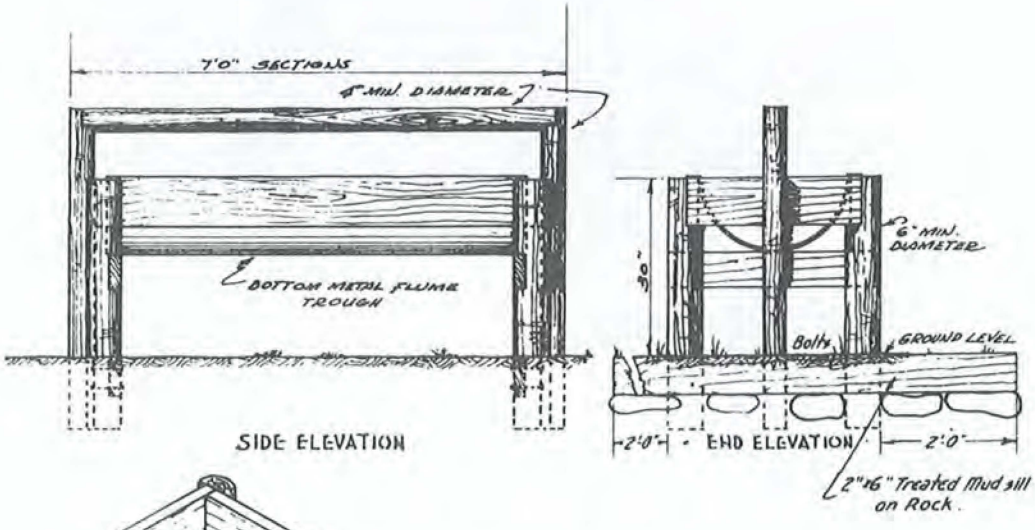


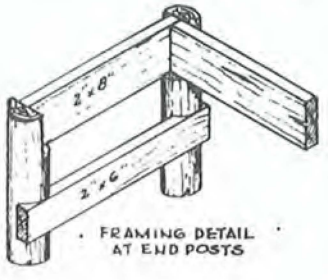

PLAN 360-1a

Hydraulic Ram

PLAN 360-2





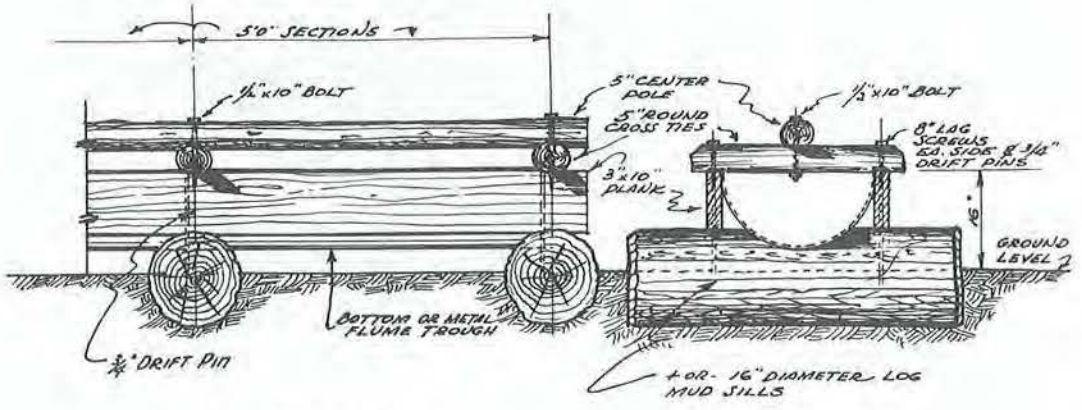




FOR LONGER TROUGHS SET MORE POSTS ALONG SIDES WITH 2"x6" PIECES TO PREVENT SPREADING AND FOR SUPPORT OF TROUGH BOTTOM . . . MUD SILL USED ON SOFT GROUND.

- METAL FLUME TROUGH -
FOR CATTLE & HORSES

METAL FLUME TROUGH
MUD SILL BASE
FOR CATTLE & HORSES

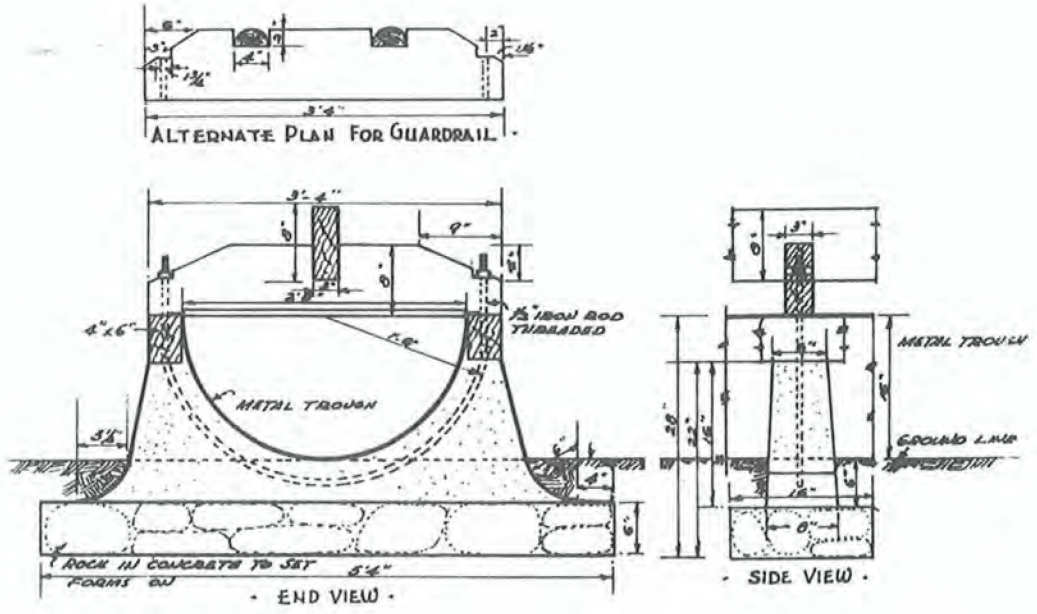
PLAN 370-1




- METAL FLUME TROUGH -
MUD SILL BASE
FOR SHEEP & GOATS -

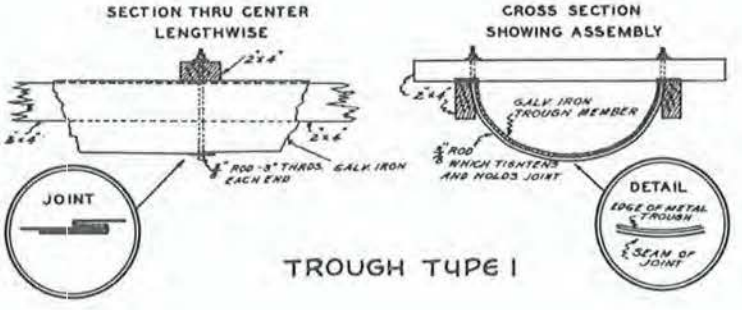
METAL FLUME TROUGH
MUD SILL BASE
FOR SHEEP & GOATS

PLAN 370-2

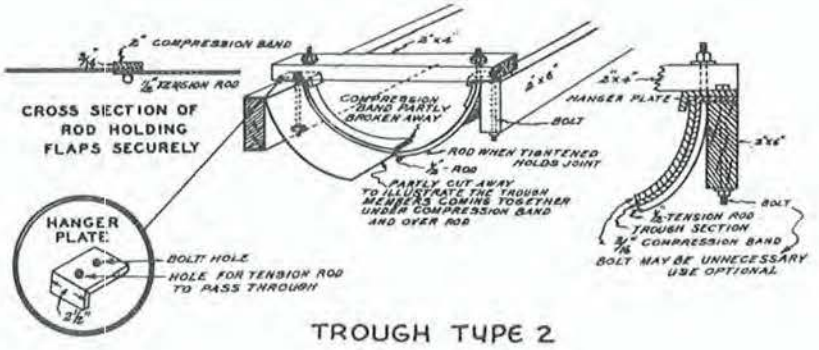



METAL FLUME TROUGH
CONCRETE BASE

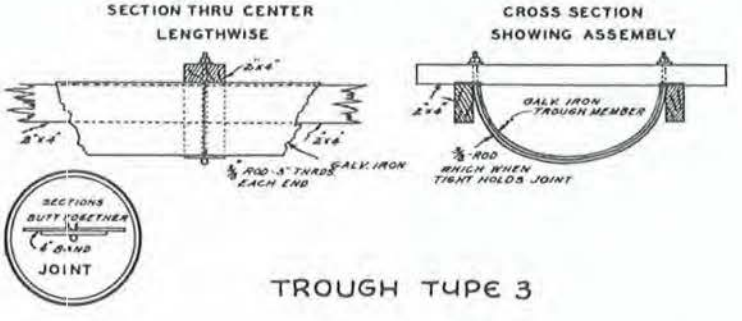
PLAN 370-3




TROUGH TYPE 1


2" COMPRESSION BAND
TENSION ROD
CROSS SECTION OF ROD HOLDING FLAPS SECURELY
COMPRESSION BAND PARTLY BROKEN AWAY
HANGER PLATE
BOLT
ROD WHEN TIGHTENED HOLDS JOINT
PARTLY CUT AWAY TO ILLUSTRATE THE TROUGH MEMBERS COMING TOGETHER UNDER COMPRESSION BAND AND OVER ROD
TENSION ROD
TROUGH SECTION
COMPRESSION BAND
BOLT MAY BE UNNECESSARY USE OPTIONAL
HANGER PLATE
BOLT HOLE
HOLE FOR TENSION ROD TO PASS THROUGH

TROUGH TYPE 2



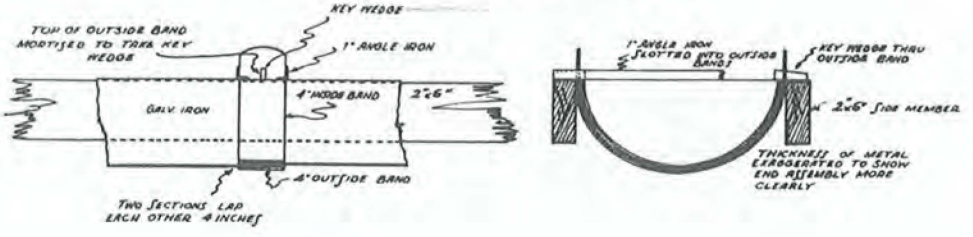

TROUGH TYPE 3

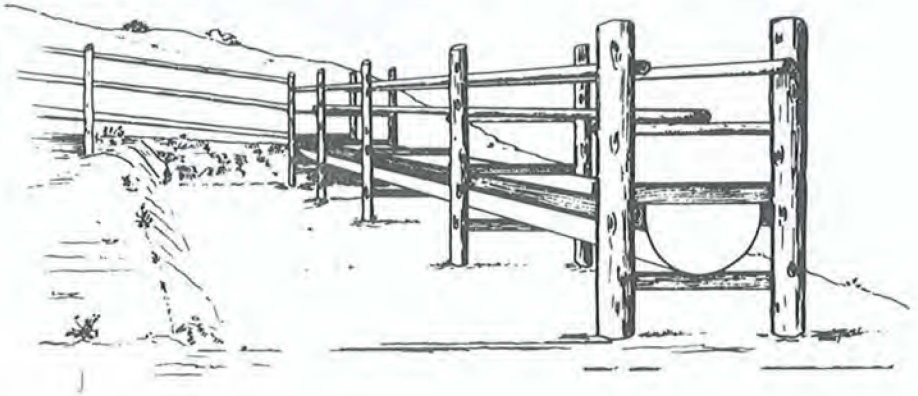
NOTE:
Also see plans for concrete and wooden trough bases.
Tension rods not needed on short troughs with strong bases.

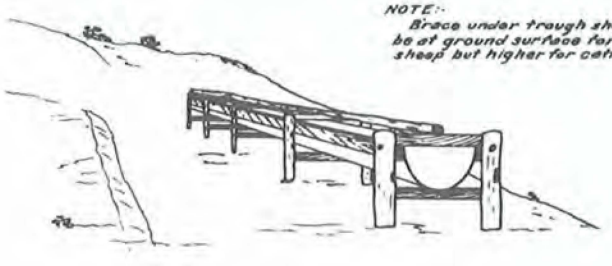
## METAL FLUME TROUGH JOINT DETAILS

PLAN 370-4

TROUGH TYPE 4

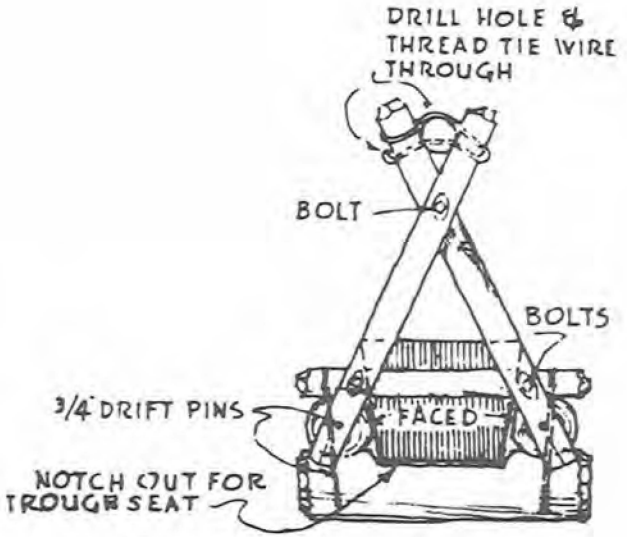

KEY WEDGE
TOP OF OUTSIDE BAND MORTISED TO TAKE KEY WEDGE
1" ANGLE IRON
GALV. IRON
4" HOOP BAND
2"x6"
4" OUTSIDE BAND
TWO SECTIONS LAP EACH OTHER 4 INCHES
1" ANGLE IRON SLOTTED INTO OUTSIDE BAND
KEY WEDGE THRU OUTSIDE BAND
2"x6" SIDE MEMBER
THICKNESS OF METAL EXAGGERATED TO SHOW END ASSEMBLY MORE CLEARLY



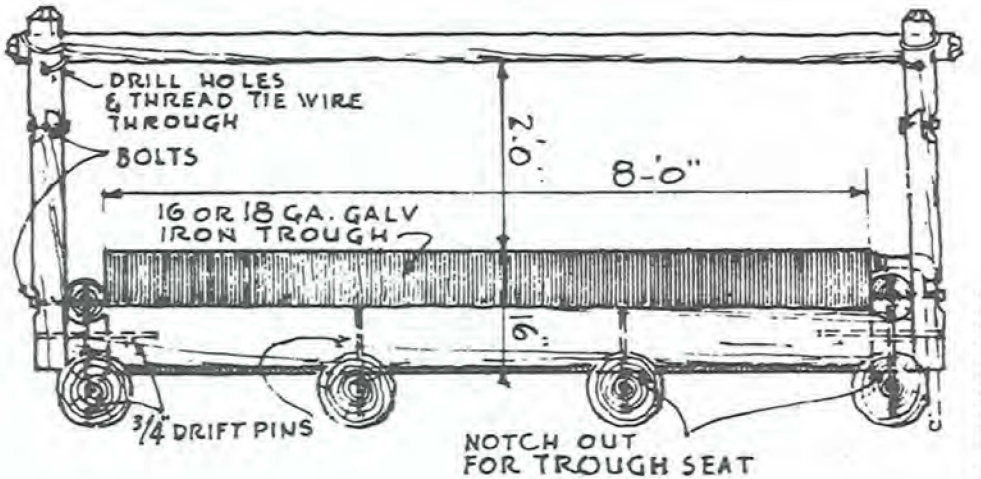



METAL FLUME TROUGH
GENERAL VIEW & JOINT DETAILS

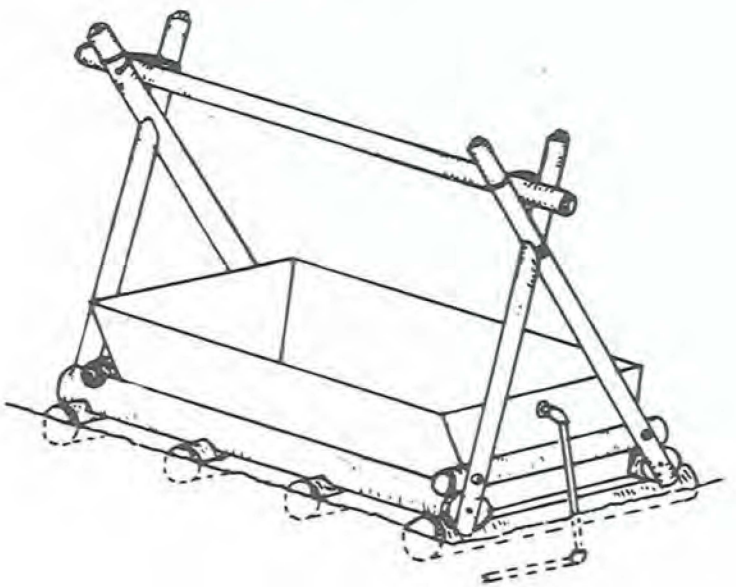
PLAN 370-5




END VIEW



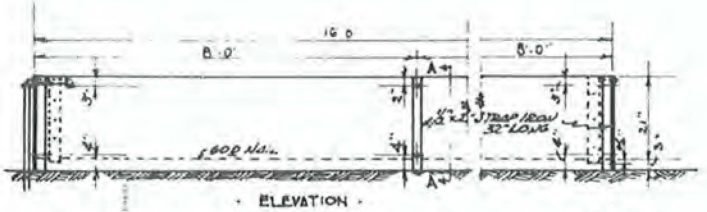

SIDE VIEW



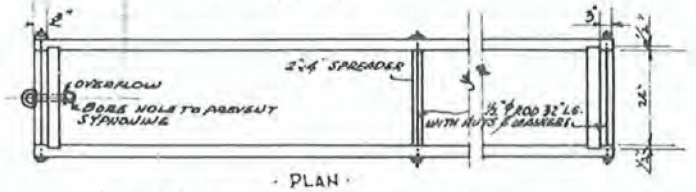
DIAGRAMMATIC VIEW OF INSTALLATION

POLE FRAMING
FOR METAL TROUGH
PLAN 370-6

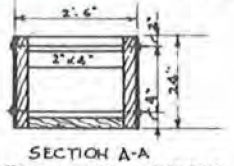
# STRUCTURAL RANGE IMPROVEMENT HANDBOOK



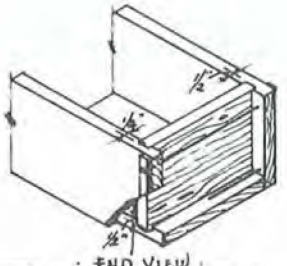

· ELEVATION ·




· PLAN ·




SECTION A-A
CAPACITY APPROX. 375 GALS.

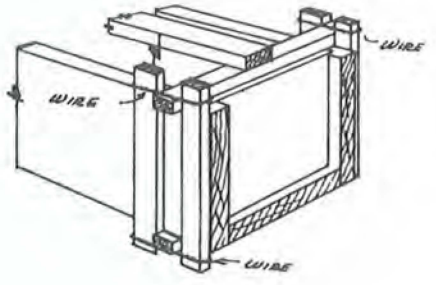


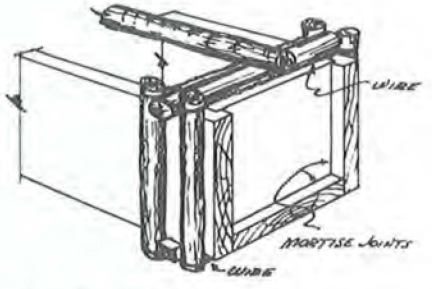

· END VIEW ·

DAD AND BOARDS INTO SIDES AND BOTTOM 1½" AS SHOWN

* Note: Waterproof glue 3x12's together, if 3x24's are not available using standard wood clamps

| BILL OF MATERIAL | | |
|---|---|---|
| ITEM | NO. | SIZE |
| Planks | 3 | 3"x24"x16'-0" Sides & ends |
| Planks | 1 | 8"x28"x16'-0" Bottom |
| Rods | 6 | ½"x32" with bolts & washers |
| Strapiron | 6 | ½"x2"x24" |
| Nails | 20 | 60d |
| Spreader | 1 | 2"x4"x24" |

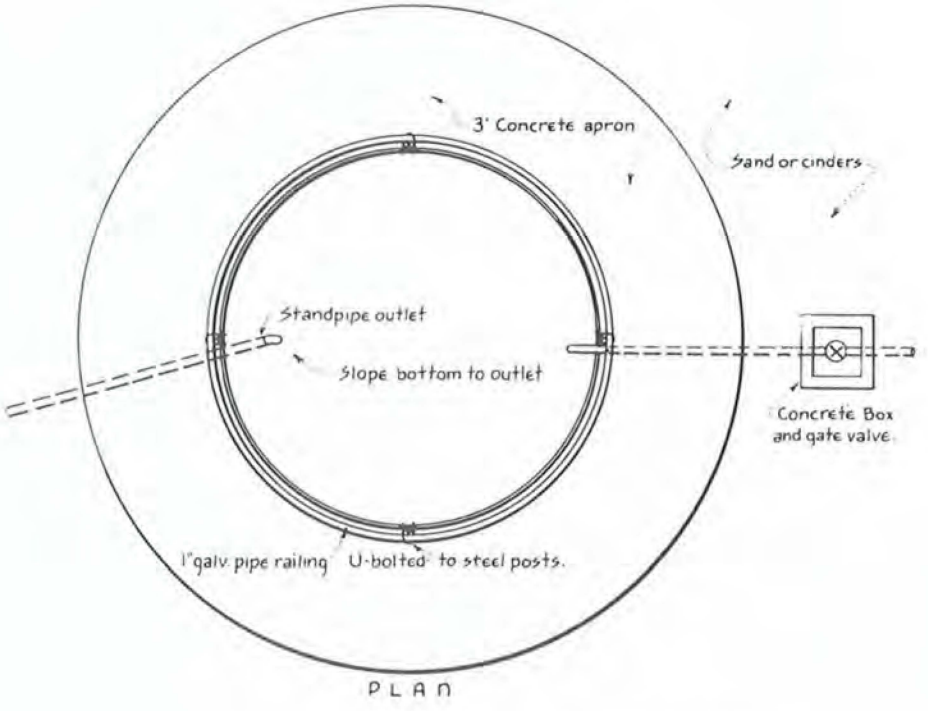


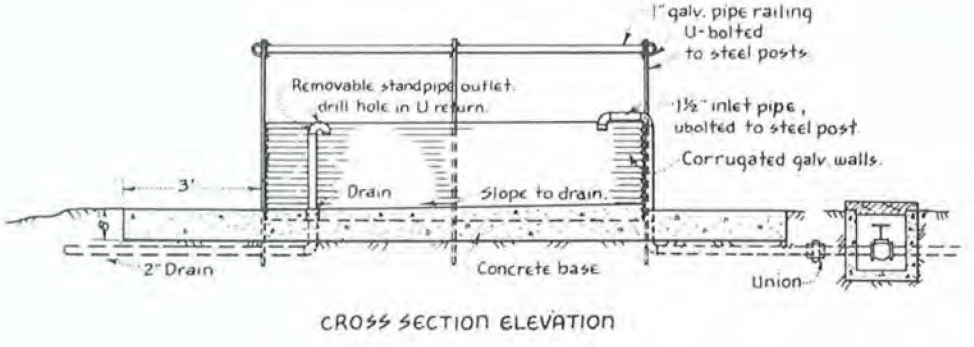




ALTERNATE TYPES OF FASTENING THE TROUGH

## PLANK TROUGH

PLAN 370-7

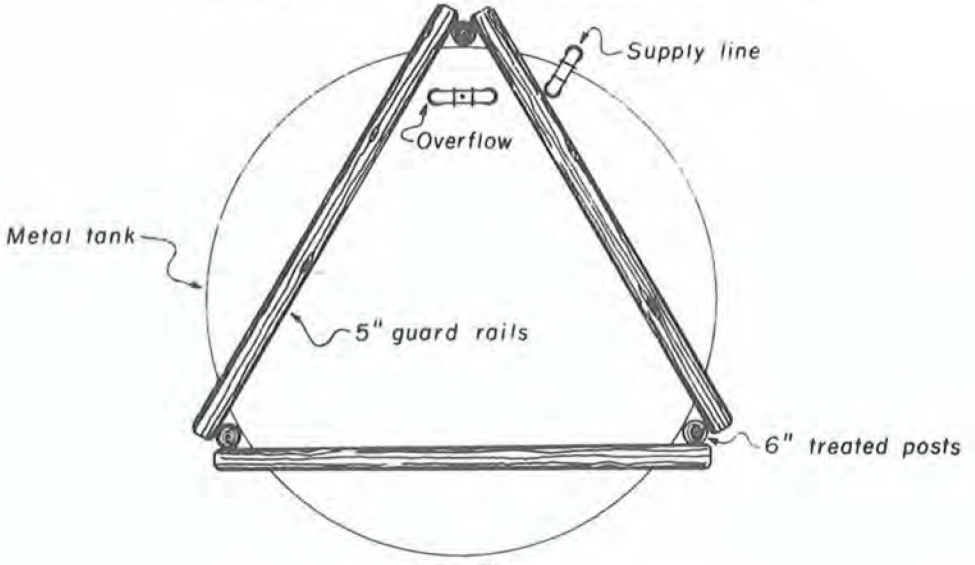


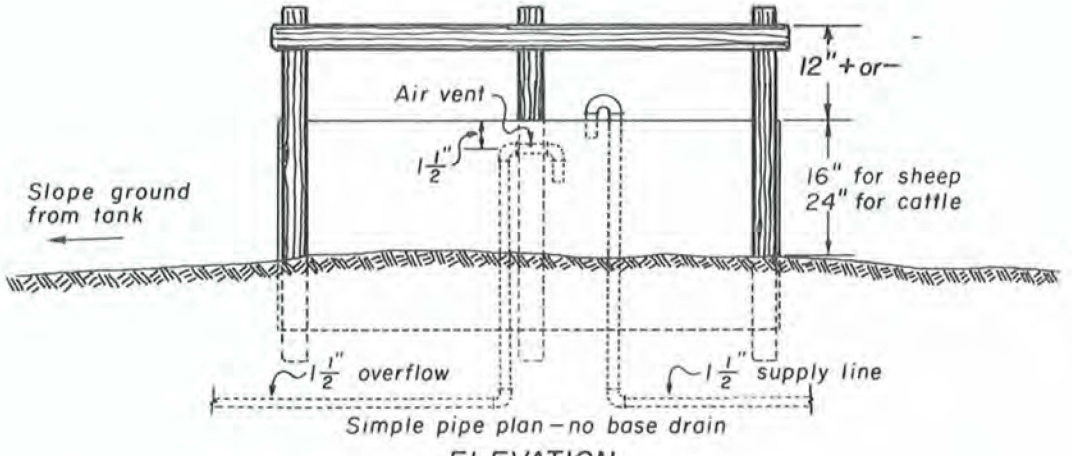

NOTE: SET TROUGH INTO CONCRETE BASE AND POUR 2" TO 3" CONCRETE INTO TROUGH TO FORM SLOPED BOTTOM. PUDDLE WELL AROUND SIDES OF TROUGH AND DRAIN PIPE.

METAL CIRCULAR TROUGH
BOTTOMLESS TYPE

PLAN 370-8

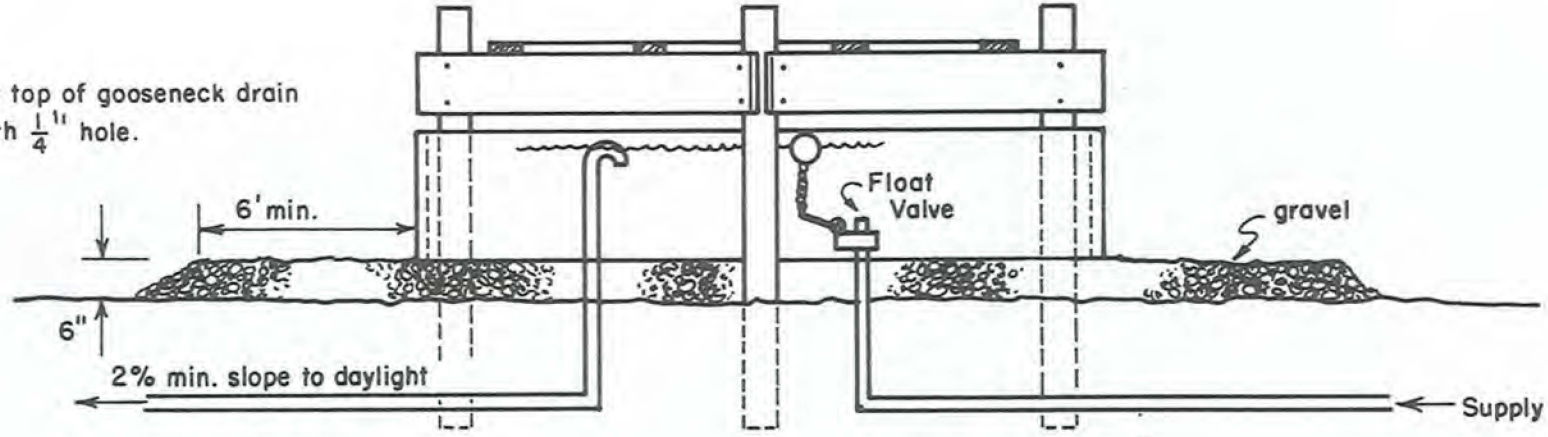


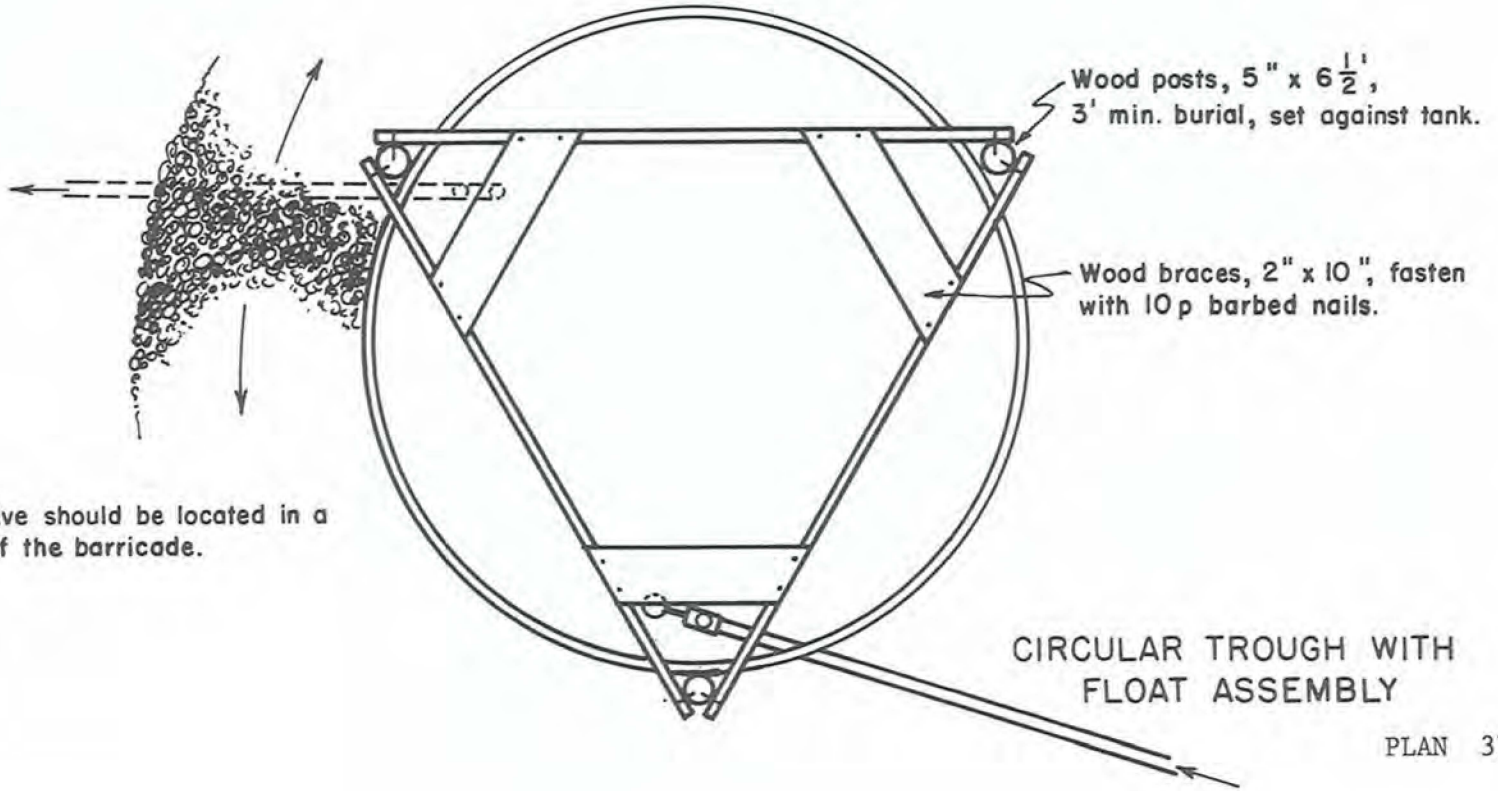

PLAN




ELEVATION

CIRCULAR METAL TROUGH
BOTTOMED TYPE

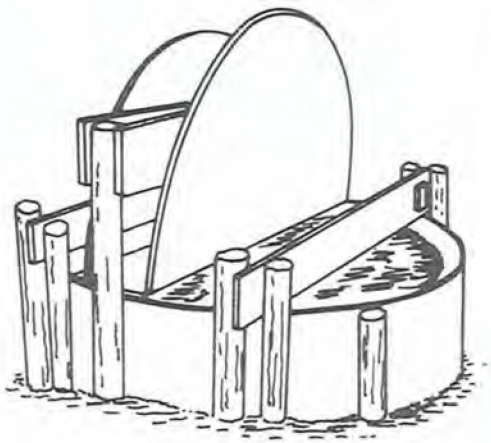


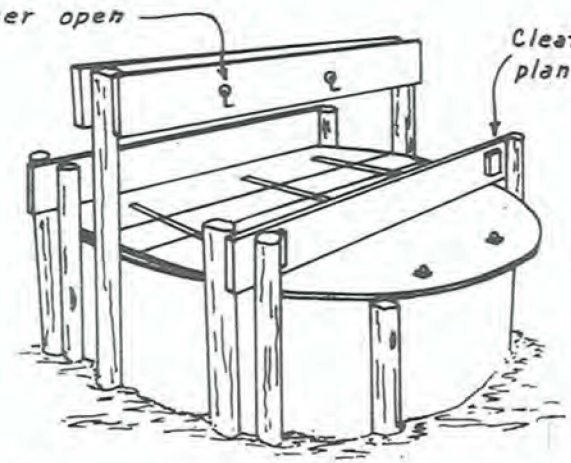

Float valve should be located in a corner of the barricade.

CIRCULAR TROUGH WITH FLOAT ASSEMBLY

PLAN 370-10



Showing the tank opened by latching the tank covers




Showing the closed tank after removing the two loose planks, lowering the covers and replacing the planks.

An effective way to close off a stock watering tank on on those allotments where water controls livestock distribution.

This method was used where a tank collected water by pipeline from a reservoir, then overflowed into another pipeline to supply water for other management units.

## CLOSING WATER TROUGH

PLAN 370-11

# STRUCTURAL RANGE IMPROVEMENT HANDBOOK

## CHAPTER 400 - OTHER STRUCTURES

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411 Cattle Corrals and Chutes

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421 Bridges

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431.2 Livestock-Big Game Range Exclosure
431.3 Livestock-Big Game Range Exclosure "Outrigger" Fence
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432 Utilization Cages

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442 Livestock Oilers

443 Salting Facilities

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Plan 410-1 Cattle Corral and Chute
Plan 410-2 Cattle Corral Chute
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Plan 430-1 Livestock-Big Game Range Exclosure

STRUCTURAL RANGE IMPROVEMENT HANDBOOK

CHAPTER 400 - OTHER STRUCTURES

410 - CORRALS AND CHUTES. The Forest Service will build corrals only when needed for range management. Plans, sanitation, location, and size will be discussed with permittees. Corrals should be located on dry, well-drained soil. Corrals will not be built on live water or where drainage directly pollutes streams. Consider hazards to plant cover and soil erosion when planning. Allow space for parking and turning trucks and tractor trailers at shipping corrals.

411 - Cattle Corrals and Chutes. Corrals must be sturdy and seldom less than 6 feet high. Gates must be free-swinging and strong. A set of corrals should have at least three parts: (1) A large roundup corral, (2) a smaller working corral connected to the large corral, and (3) a lane 30 to 40 feet long and 8 feet wide leading to a loading chute. A squeeze may be installed midway in the lane. Poles are the best corral material if cost is reasonable. Sawed material should be 2- by 6-inch or 2- by 8-inch planks.

Manufactured head catchers and squeezes are usually less expensive and better than homemade. Many models are portable.

412 - Sheep Corrals and Chutes. Two types of corrals may be necessary on sheep range. Sorting corrals may be required on driveways and where mixing is likely. Simple counting corrals will suffice on other ranges.

The height of the corral should not be less than 3 feet 6 inches. Poles may be used in place of boards or board panels. Poles should have at least a 3-inch top diameter.

All chutes and runways should have solid board sides so sheep cannot see out. Separating chutes or runways should be 18 to 24 feet long, 4 feet high, and 18 to 24 inches inside width. Loading chutes and runways must withstand rough use.

420 - STOCK DRIVEWAYS. Many operators are using improved transportation facilities to haul rather than trail stock. This should be encouraged. The Forest Supervisor should be consulted before existing driveways are rerouted or new ones established. Users should be encouraged to do needed maintenance.

Many driveways are poorly located on ridgetops and steep erosive slopes. These should be eliminated or relocated as opportunities arise. Driveways should be on comparatively smooth and level ground where livestock will cause the least damage to all resources. Low standard roads may provide the most service with the least resource damage and cost.

Stock driveways are classed as special trails with standards based on the amount of use. They are part of the approved Forest trail system. Allotment distribution trails are built for access to forage and water. Range improvement funds may be used to build and maintain distribution trails. However, maintenance should ordinarily be assigned to permittees.

All driveways will be posted with standard center and boundary signs. They should seldom be posted more than 200 feet wide across open areas. The amount of clearing through heavy brush and timber depends on the kind and number of livestock--12 to 20 feet is usually adequate.

Driveway administration is an important part of the range job. Use should be regulated to prevent damage to the driveway, bedgrounds, or camps. Instructions for crossing permitted livestock should be included in the permittees' annual management instructions. Crossing permits can be required as necessary to control driveway use.

421 - Bridges. Many streams require bridges for sheep crossing. Bridges for cattle may be needed only for crossing deep, swift streams with poor approaches.

Often a simple temporary bridge is adequate. A plan for a simple sheep bridge for occasional use is given at the end of this section. Three or four logs can be pinned together and pole chinked to make a temporary bridge for sheep or cattle. Permittees will be encouraged to construct and maintain these bridges.

If a bridge will have heavy use, construction will conform with the specifications in the Trail Handbook. Such structures require competent technical skill, experience, and engineering assistance.

On livestock range, remember that stock may hesitate to cross wooden or metal structures, especially if they tend to sway. It is often better to use a culvert and fill than to build a bridge. If a permanent bridge must be built, use treated wooden decking with a light cover of dirt to reassure livestock. A dirt tread is safer than wood or metal when frosty.

STRUCTURAL RANGE IMPROVEMENT HANDBOOK

| | |
|---|---|
| Plan 430-2 | Livestock-Big Game Range Exclosure "Outrigger" Fence |
| Plan 430-3 | Stile for "Outrigger" Fence |
| Plan 430-4 | Cattle Exclosure-Open to Big Game |
| Plan 430-5 | Pyramid-Type Utilization Cage |
| Plan 430-6 | Cylindrical Open-Top Cage |
| Plan 430-7 | Prefabricated Custom-Built Agronomy Cage |
| Plan 430-8 | Utilization Cages |
| Plan 440-1 | Portable Cattle Shade |

For livestock to cross freely, it is usually better to fill and install culverts across swampy areas than to use corduroy (poles laid horizontally across trail and touching adjacent poles full length) and bridge. Sometimes ditching powder can be used to blast ditches to collect the water into a single culvert.

## 430 - STUDY FACILITIES

431 - Exclosures. These are built to exclude or control grazing by livestock and/or big game on small areas. These might be:

1. Demonstration areas.
2. Relict areas.
3. Small areas for administrative study. (See FSM 1342.)
4. Grouse watering or nesting places.
5. Instrument installation sites.

There should be safe and easy access for humans. If gates are not needed, stiles or ladders will be provided.

The location will depend on the purpose of the exclosure. Usually easy access for construction, maintenance, and observation is important. Avoid snowdrift areas. Exclosure protection demonstration areas, relict areas, and administrative studies must be at least 1 acre in size. Identifying signs should include date the exclosure was constructed and other pertinent information.

431.1 - Livestock Range Exclosures. Exclosures on large areas of open range may vary from 1 to 5 acres in size. Fence may be any acceptable design but wooden posts with wire is preferred. In heavy snow areas letdown or pole fences are best. On sheep ranges, use woven wire about 32 inches high. On common-use range add two barbed wires on top, spaced 8 inches apart.

A square barbed wire exclosure with 216-foot sides will contain slightly over 1 acre and requires the following materials:

STRUCTURAL RANGE IMPROVEMENT HANDBOOK

| CATTLE RANGE | SHEEP RANGE | SPECIFICATIONS |
|---|---|---|
| 20 corner and brace posts | same | 5" top, 6½' long |
| 56 line posts | same | 4" top, 6' long |
| 60 stays | same | 2" top, 4' long |
| 240 rods barbed wire (includes brace wire) | 54 rods 32-inch woven wire and 120 rods barbed wire | standard |
| 7 pounds staples | 10 pounds staples | 1½-inch |
| 8 braces, horizontal | same | 4" top, 8' long |
| 8 braces, diagonal | same | 4" top, 12' long |
| 6 pounds nails[1/] | same | 60d |
| 200 feet brace wire | same | No. 9 (if barbed wire not used) |

1/ 40d nails may be substituted to reduce splitting: 4 pounds are required.

A more desirable size of cattle exclosure is 3 acres (22 rods square). It should be 42 inches high with four wires and line posts 1 rod apart, and requires:

| Materials | Specifications |
|---|---|
| 20 corner and brace posts | 5-inch top, 6½ feet long |
| 76 line posts (steel or wood) | 5½ feet to 6 feet long |
| 160 stays (2 per rod) | |
| 5 rolls barbed wire | 80-rod |
| 10 pounds staples (if wood line posts used) | |
| 8 brace poles | 4 inches x 8 feet |
| 8 brace poles | 4 inches x 12 feet |
| 4 pounds nails | 40d |
| 200 feet smooth wire for braces | No. 9 |

431.2 - Livestock - Big-Game Range Exclosure. A 7-foot fence will usually exclude elk or deer. If snowdrift areas cannot be entirely avoided, a higher fence is required through the drift zone.

A square, wire fence exclosure, 7 feet high with 216-foot sides, requires:

| Materials | Specifications |
|---|---|
| 20 corner posts | 6-inch top, 10 feet long |
| 36 line posts (steel or wooden) | 4-inch top, 10 feet long or "T" stud |
| 32 line posts | 6-inch top, 10 feet long |
| 8 braces, horizontal | 5-inch top, 8 feet long |
| 8 braces, diagonal | 5-inch top, 14 feet long |
| 1 spool barbed wire | |
| 300 feet galvanized wire | No. 9 |
| 20 pounds staples | 1½-inch |
| 6 pounds[1/] | 60d |
| 106 rods woven wire | 39-inch |
| 200 hog rings | |

1/ If 40d nails are used, 4 pounds are required.

431.3 - Livestock - Big-Game Range Exclosure "Outrigger" Fence. "Outrigger" fences effectively control big game animals by keeping them away from fences they otherwise could jump over easily. In snowdrift areas a high fence as described earlier may be needed.

The general construction information is:

Woven wire 48" high on wood posts spaced on 12-foot centers. Barbed or barbless wire on 2" x 4" by 8-foot long wood outriggers. Wire spacing is 12", 24", 36", 48", 60", 72", and 84" from ground end of outrigger. Fence ladder is built midway between two lineposts.

A square exclosure with 212-foot sides fenced 4 feet high and 8 feet wide requires:

| Materials | Specifications |
|---|---|
| 20 corner posts | 5-inch top, 7 feet long |
| 56 line posts | 4-inch top, 6½ feet long |
| 8 horizontal braces | 4-inch top, 8 feet long |
| 8 diagonal braces | 4-inch top, 10 feet long |
| 80 outriggers | 2" x 4", 8 feet long (can be poles) |
| 80 stakes | 2" x 4", 2 feet long |
| 2 3/5 - 20 rod rolls of wire net | 47", 11 gage top and bottom wires, 12½ gage mesh |
| 5-80 rod rolls wire | 12½ gage barbless twisted |
| 800 feet brace and tie wire | No. 9 galvanized |
| 2 pounds nails | 4d |
| 7 pounds nails | 20d |
| 2 pounds nails | 16d |
| 5 pounds staples | 1½ inch |
| 8 pounds staples | 1 inch |
| Ladder materials: | |
| 1 post | 6-inch top, 9½ feet long |
| 1 post | 6-inch top 7½ feet long |
| 1 post | 6-inch top, 4½ feet long |
| 1 handrail | 2" x 4", 12 feet long |
| 2 rails (sides) | 2" x 6", 12 feet long |
| 2 rails (steps) | 2" x 4", 16 feet long |

431.4 - Livestock Exclosure - Open to Big Game (Jump-Over Exclosure). This exclosure is intended to exclude livestock but provide easy access by deer and elk.

Cattle range fence:

Use two wires and a rail. Space wires 14 and 22 inches, and rail 32 inches above the ground. Posts should be set 12 feet apart.

Sheep range fence:

Use 32-inch woven wire stapled to posts and a rail at the top. Posts should be set 12 feet apart.

The following materials are needed when one side is common to a 216-foot per side game-proof exclosure:

| Cattle range | Sheep range | Specifications |
|---|---|---|
| 14 corner posts | same | 5-inch top, 5½ feet long |
| 39 line posts | same | 4-inch top, 5 feet long |
| 54 rails | same | 3-inch top, 14 feet long |
| 80 rods barbed wire | none | |
| None | 40 rods woven wire | 32-inch |
| 5 pounds staples | 6 pounds staples | 1½-inch |
| 12 pounds nails | same | 40d |

No brace material is needed since top rails give adequate bracing. All rails should be notched to fit posts. Rails can be held with one 60d nail at each end but two 40d nails driven at angles from each side are better.

431.5 - Pilot Plot Fences. Pilot plots are established to determine planting methods, treatments, and species best used to rehabilitate larger adjacent range areas. A fence may be needed. If so, it should enclose not less than 1 acre, especially if retained for future studies. If several treatments are tested, 2½ to 5 acres or more may be needed. Type of fence is governed by need.

Where rabbits are prevalent, the fence can be made rabbit-proof with 36-inch poultry neeting, 1-inch mesh, extending at least 6 inches into the ground.

432 - Utilization Cages. There are many acceptable kinds of cages in use. No attempt is being made to standardize construction. Some examples are shown at the end of this chapter.

## 440 - MISCELLANEOUS FACILITIES

441 - Cattle Shade. In some eastern areas of the Region, there is little natural shade and artificial shade may be important. It may be needed by the animals and could be important in managing the range. Shade may occur naturally only along drainages. Cattle continually trample these areas until this woody cover is severely damaged and even destroyed. Artificial shade may benefit the animals and also promote distribution, thereby benefiting the range.

Available woody cover may be needed by game or game birds. The bottoms are often primary livestock range. Artificial shade may move stock into secondary areas.

441.1 - Portable Cattle Shade. Instructions: Build roof in 10- by 12-foot sections. Materials needed for two sections are:

| | |
|---|---|
| 8 | 2- by 4-inch by 10-foot lengths, lumber |
| 4 | 2- by 6-inch by 10-foot lengths, lumber |
| 6 | 10-foot posts, 5-inch tops |
| 10 | Sheets, 26 inches by 12 feet, galvanized roofing. |
| | Bolts and nails as needed. |

Sections are fastened to the upright posts with bolts through the 2- by 6-inch stringers. Any number of sections can be added to increase the length of the shelter. When this is to be done, the 2- by 6-inch stringers should be at the edges of the 10- by 12-foot sections. For moving, the roof sections can be detached by removing the bolts at the corner posts. Then the upright posts are pulled after digging or drilling alongside. Roof sections and posts can then be hauled to new location by flatbed truck or trailer.

Sway braces can be bolted to the upright posts for more stability but are not necessary on lightweight roofs.

Metal roofing should be grounded for lightning protection.

442 - Livestock Oilers. Livestock oilers promote better gains on cattle. Better distribution results when stock are not bothered by flies. Once cattle are accustomed to oilers, they may be used to promote distribution as is commonly practiced with salt.

Several commercial types are available. Some stockmen use homemade oilers.

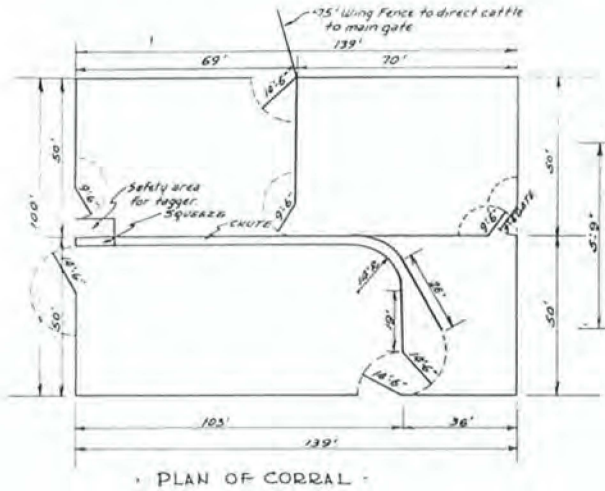
443 - Salting Facilities. Various types of boxes and troughs have been used. Type varies with block or loose salt and with kind of stock. Commercial dispensers are available.

Often when single blocks of salt are used, they are set on a metal or wooden stake.

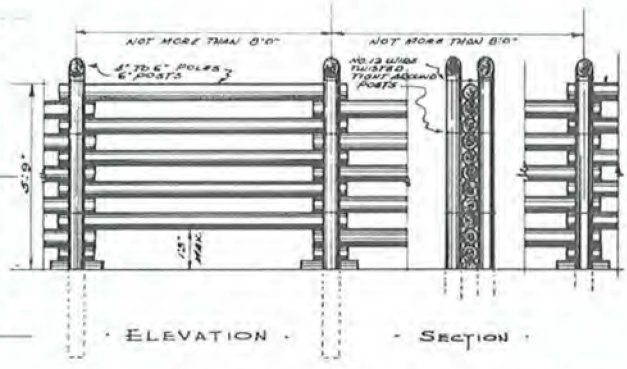
Under the area system of salting, amount of salt placed at each location will vary. This will influence the type of salting facility used.

STRUCTURAL RANGE IMPROVEMENT HANDBOOK

## 490 - STRUCTURAL PLANS

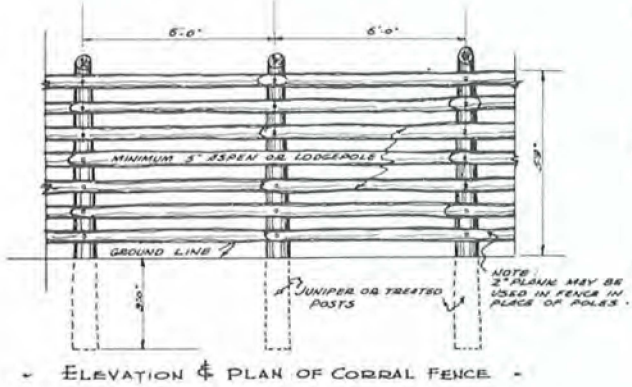



· PLAN OF CORRAL ·

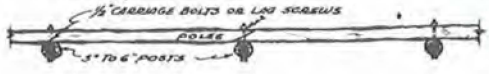


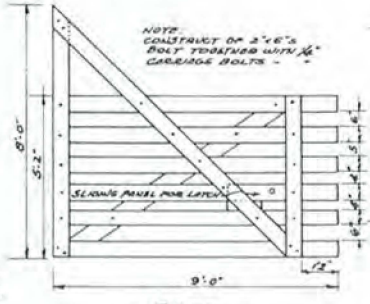

· ELEVATION · · SECTION ·

· LOG PANEL CORRAL FENCE · (ALTERNATE)

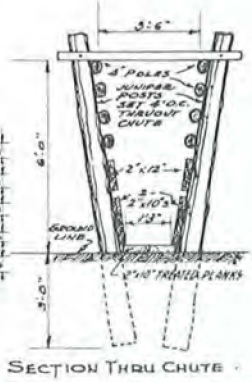



· ELEVATION & PLAN OF CORRAL FENCE ·




· GATE ·

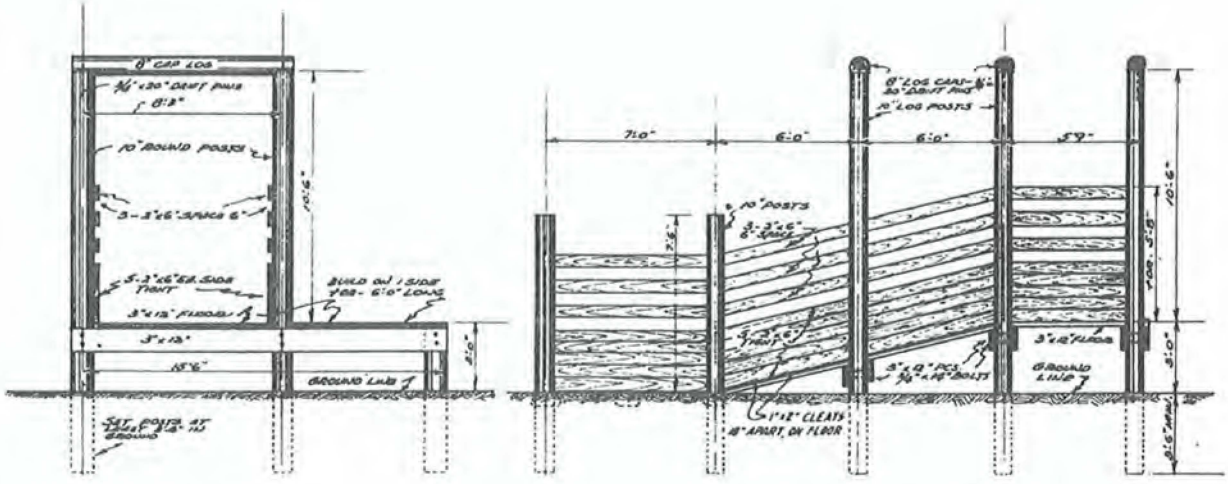



· SECTION THRU CHUTE ·

CATTLE CORRAL & CHUTE

PLAN 410-1

# STRUCTURAL RANGE IMPROVEMENT HANDBOOK




- FRONT ELEVATION -

- SIDE ELEVATION -

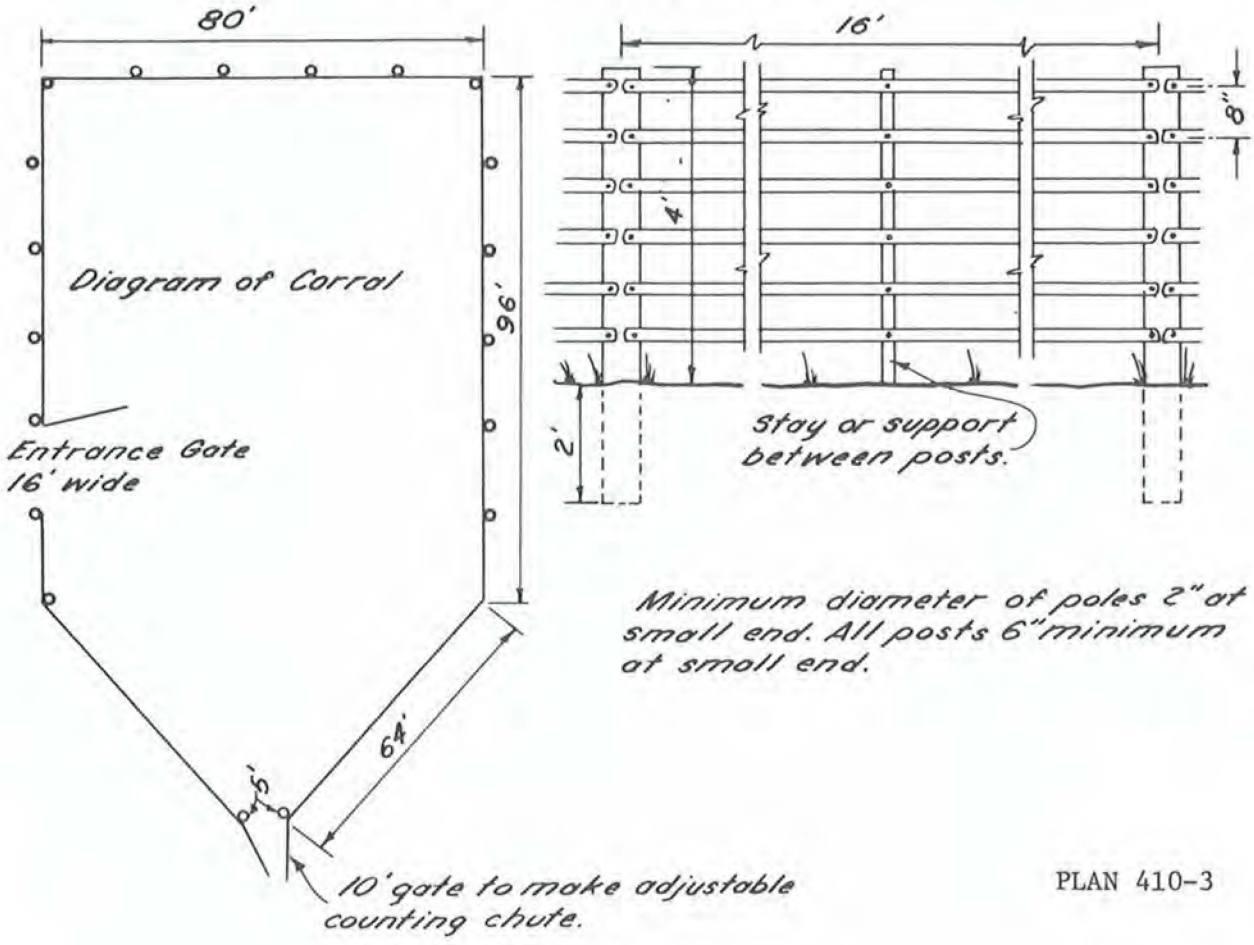
- BILL OF MATERIALS -

| ITEM # | NUMBER PCS | ITEM DESCRIPTION | PURPOSE |
|---|---|---|---|
| | | - CHUTE - | |
| 1 | 3 PCS. | 8" RD CAP LOGS - 10'0" LONG | CAP LOGS |
| 2 | 6 PCS | 10" RD. POSTS - 17'0" " | POSTS |
| 3 | 4 PCS. | 10" " " 11'0" " | " |
| 4 | 3 PCS. | 10" " " 6'0" " | " |
| 5 | 4 PCS. | 3"x8"x16'0" - 395 FBM. | SILLS |
| 6 | 2 PCS. | 8"x12"x10'0" - DO | " |
| 7 | 14 PCS. | 3"x12"x6'0" - DO | FLOOR |
| 8 | 7 PCS. | 3"x12"x12'0" DO | " |
| 9 | 7 PCS. | 3"x12"x8'0" DO | " |
| 10 | 16 PCS. | 2"x8"x7'0" DO | SIDES |
| 11 | 16 PCS. | 2"x6"x14'0" DO | " |
| 12 | 16 PCS. | 2"x8"x6'0" DO | " |
| 13 | 32 SETS | 16D COMMON NAILS | |
| 14 | 1 KEG | 60D " " | |
| 15 | 16 | 5/8"x16" BOLTS COMPLETE | |
| 16 | 6 | 5/8"x20" DRIFT PINS | |

CATTLE CORRAL CHUTE

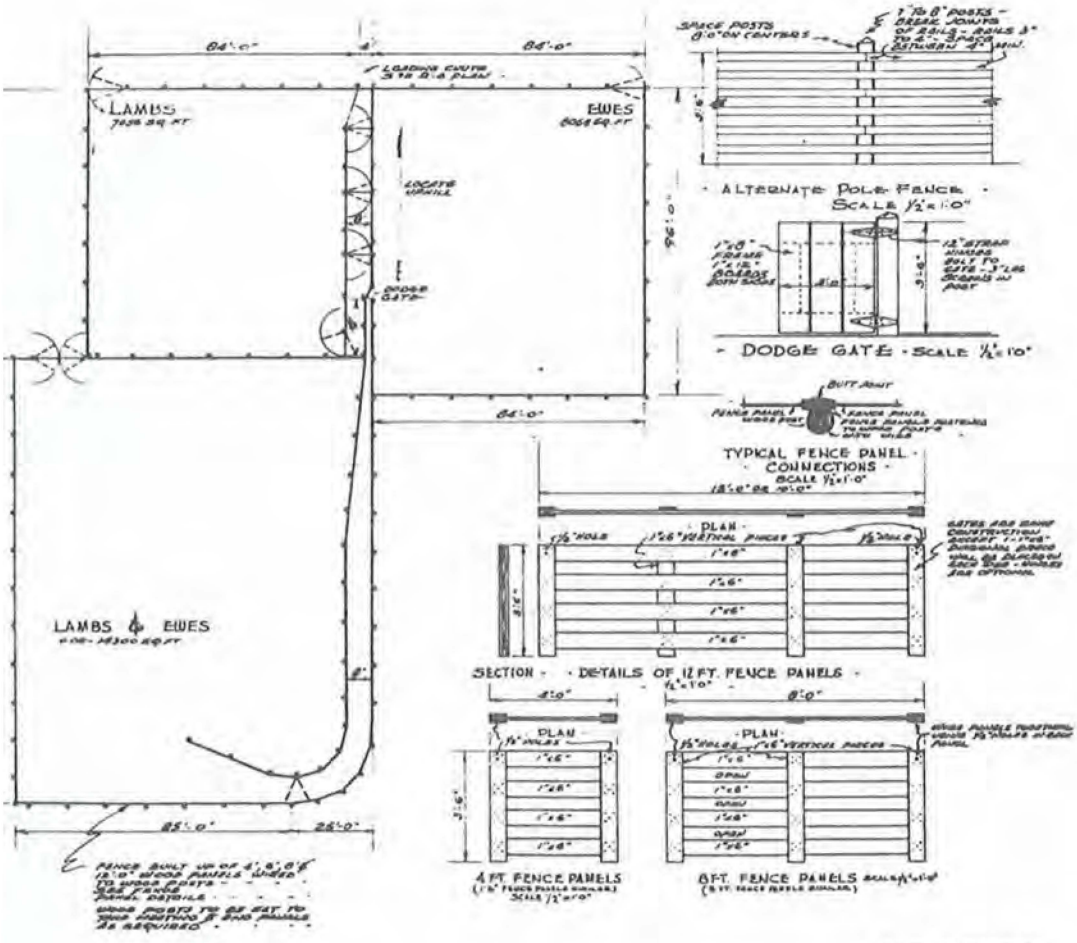
PLAN 410-2

# SHEEP COUNTING CORRAL




PLAN 410-3

# STRUCTURAL RANGE IMPROVEMENT HANDBOOK

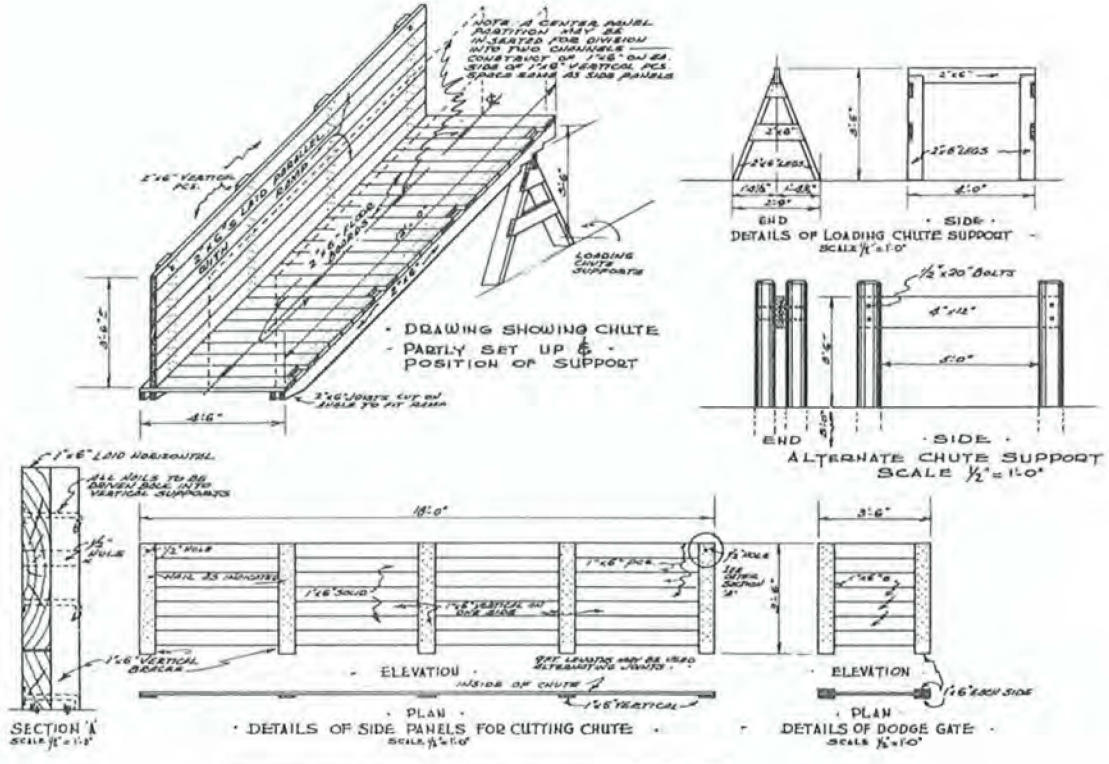



PLAN OF CORRAL
SCALE 1"=30'-0"

LOCATE UPHILL TO LOADING CHUTE

SHEEP CORRAL

PLAN 410-4

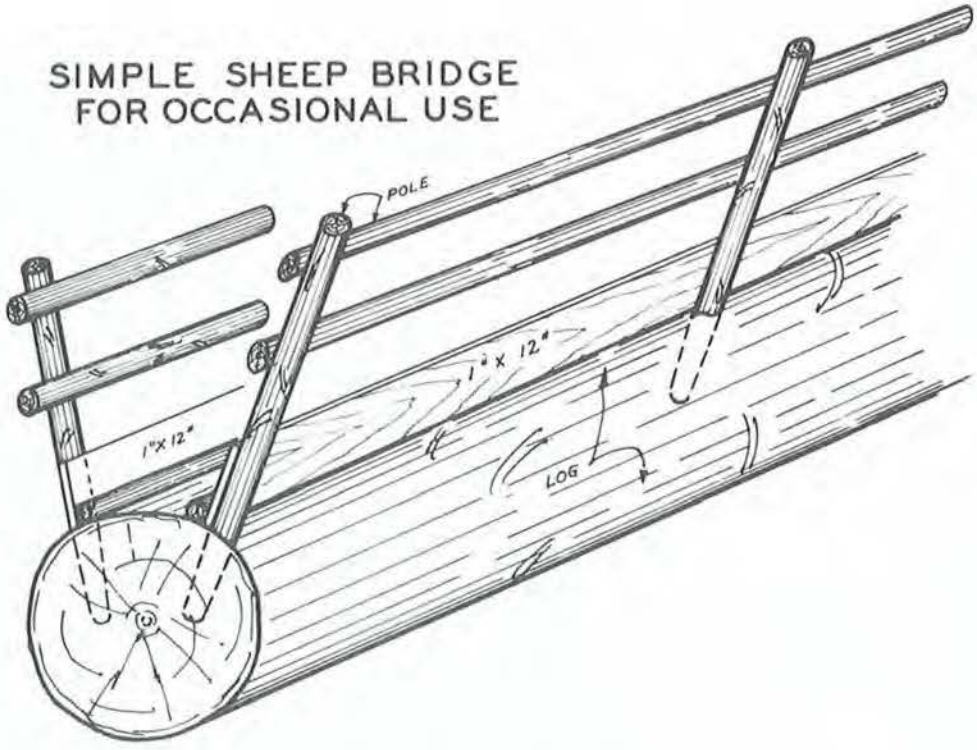


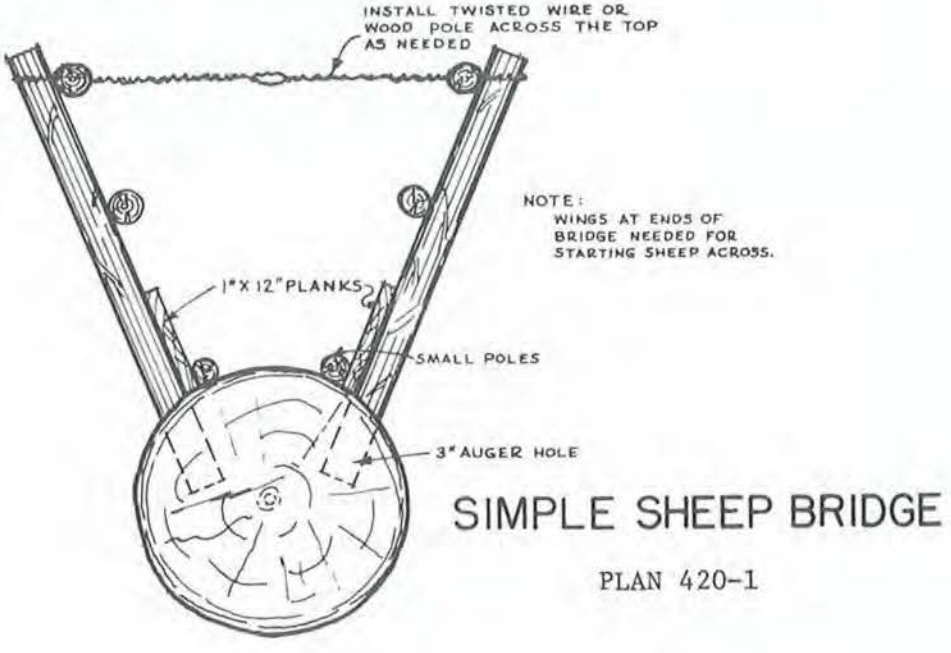

· BILL OF MATERIALS ·

| ITEM # | NO. OF PCS. | ITEM DESCRIPTION | PURPOSE |
|---|---|---|---|
| | | · CHUTE · | |
| 1 | 18 PCS. | 2"x6"x12'-0" #1 COM. DOUG FIR | JOISTS & SIDE PANELS |
| 2 | 12 PCS. | 2"x6"x9'-0" DO | FLOOR |
| 3 | 3 PCS. | 2"x6"x14'-0" DO | VERTICAL PCS. |
| 4 | 2 PCS. | 1"x6"x 7'-0" DO. PAR | " " CENTER |
| 5 | 14 PCS. | 1"x6"x12'-0" DO " | CENTER PANEL |
| | | · CHUTE SUPPORT · | |
| 6 | 3 PCS. | 2"x6"x12'-0" · DO FIR | CHUTE SUPPORT |
| | | · ALTERNATE CHUTE SUPPORT · | |
| 7 | 4 POST | 8" DIA BY 7'-0" LONG | |
| 8 | 4 | ½"x20" BOLTS - NUT, ETC. | |
| 9 | 1 PC. | 4"x12"x6'6" LONG - FIR | |
| | | · CUTTING CHUTE - 1 PANEL - 1 DODGE GATE · | |
| 10 | 5 PCS. | 1"x6"x 2'6" # FOR 24" PANS OR SIDE | |
| 11 | 7 PCS. | 1"x5"x 10'0" (OR 14 PCS. 5'0") #1 COM. DOUG FIR | |
| 12 | 35 LBS. | 8d COMMON & 20d AERO COM. FOR CHUTE, TEST CHUTE PANEL | |

SHEEP CORRAL

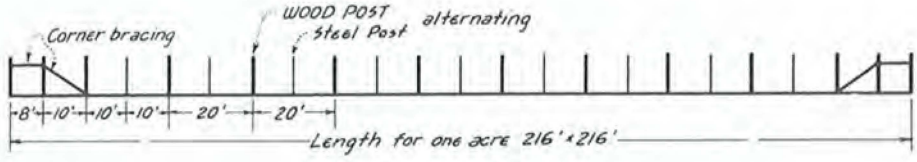
PLAN 410-5



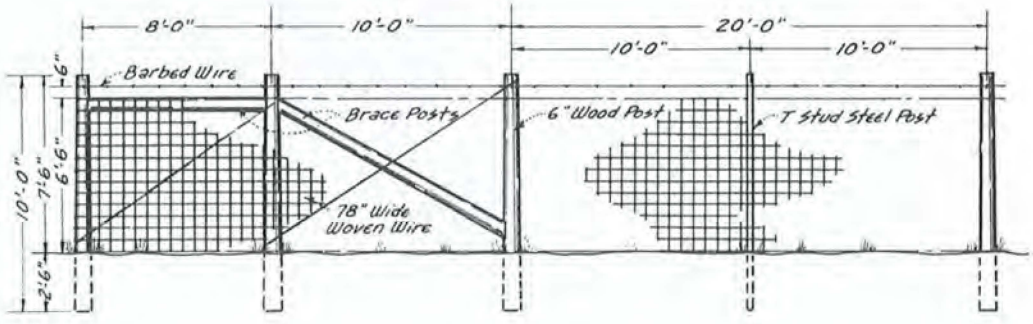




SIMPLE SHEEP BRIDGE

PLAN 420-1




SPACING DIAGRAM

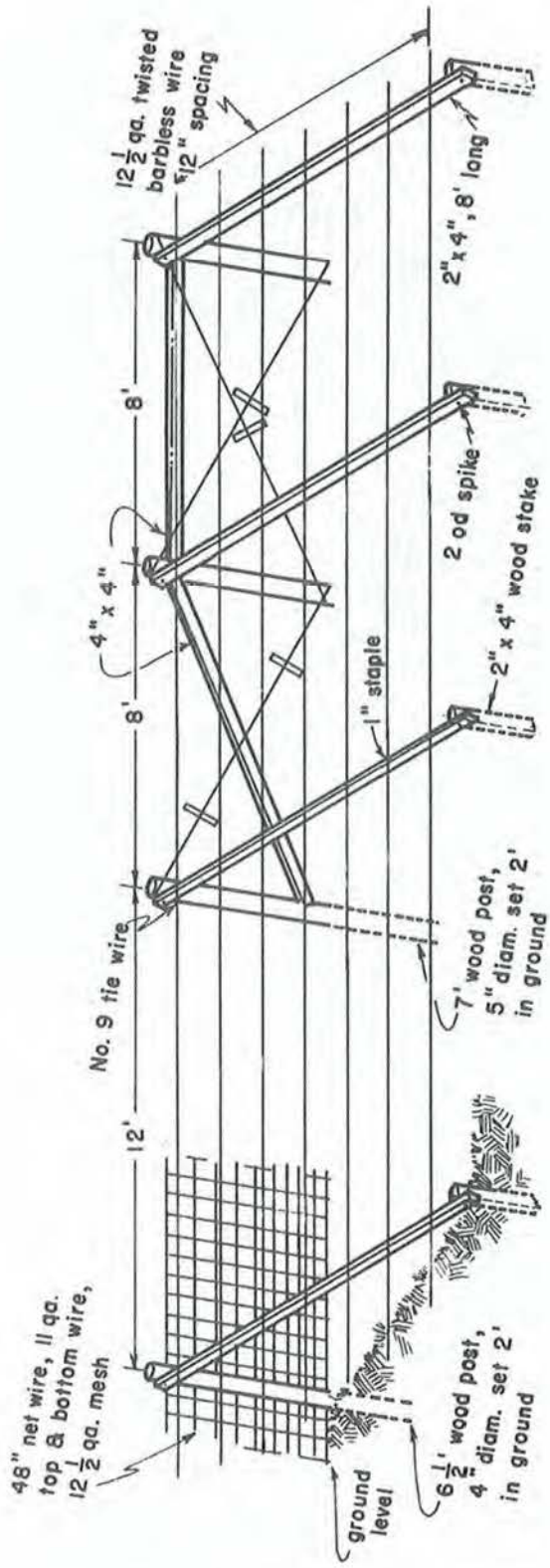



FENCE DETAIL

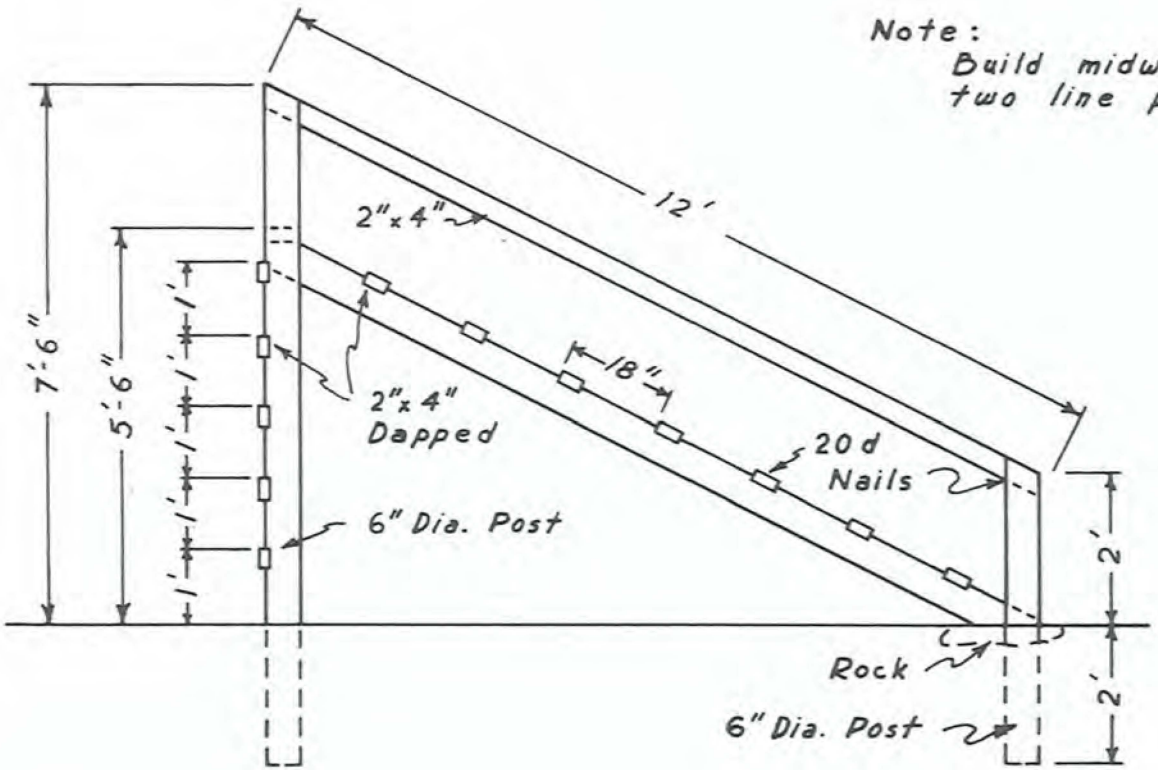
*Note: These specifications are adequate for most R-1 conditions. Heavier posts, bracing and wire are needed in unusually heavy snow conditions.*

LIVESTOCK - BIG GAME
RANGE EXCLOSURE

PLAN 430-1


12 1/2 ga. twisted barbless wire 5 1/2" spacing
2"x 4", 8' long
8'
8'
4"x 4"
2 od spike
2"x 4" wood stake
1" staple
No. 9 tie wire
12'
7' wood post, 5" diam. set 2' in ground
48" net wire, 11 ga. top & bottom wire, 12 1/2 ga. mesh
ground level
6 1/2' wood post, 4" diam. set 2' in ground

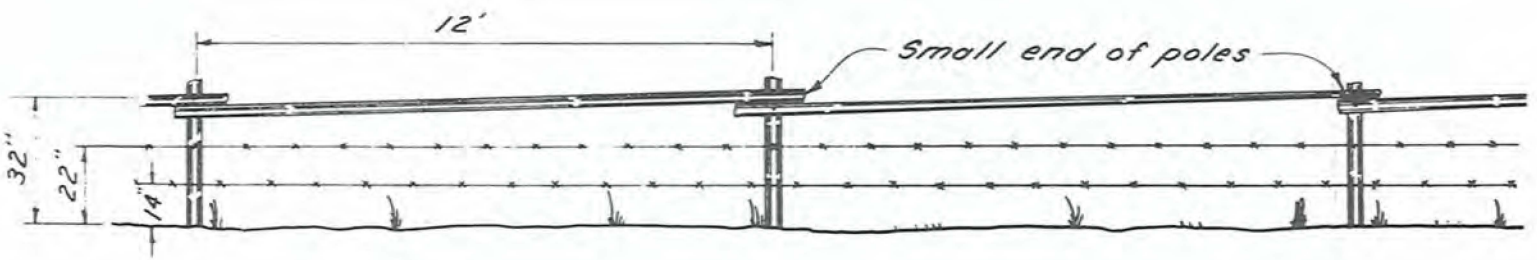
LIVESTOCK - BIG GAME
RANGE EXCLOSURE
"OUTRIGGER" FENCE
PLAN 430-2




STILE FOR OUTRIGGER FENCE

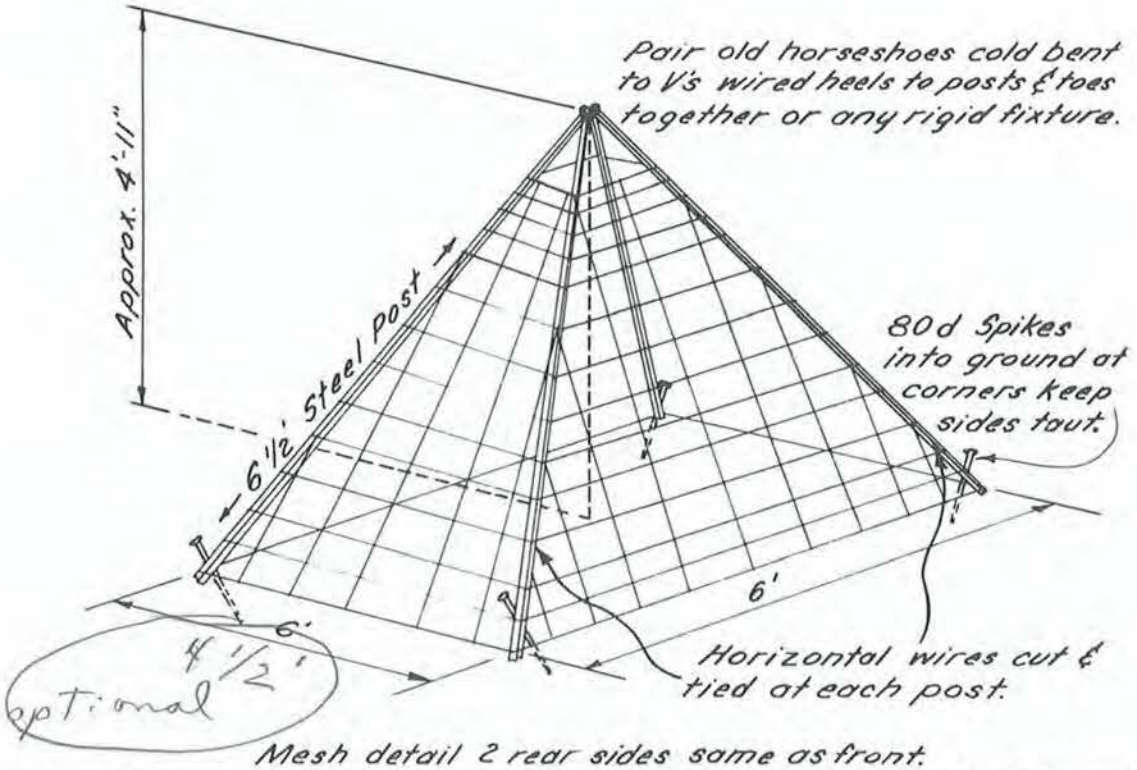
PLAN 430-3

# CATTLE EXCLOSURE - OPEN TO BIG GAME




PLAN 430-4

# PYRAMID-TYPE UTILIZATION CAGE


Pair old horseshoes cold bent to V's wired heels to posts & toes together or any rigid fixture.
Approx. 4'-11"
6 1/2' Steel Post
80d Spikes into ground at corners keep sides taut.
6'
6'
4 1/2'
optional
Horizontal wires cut & tied at each post.

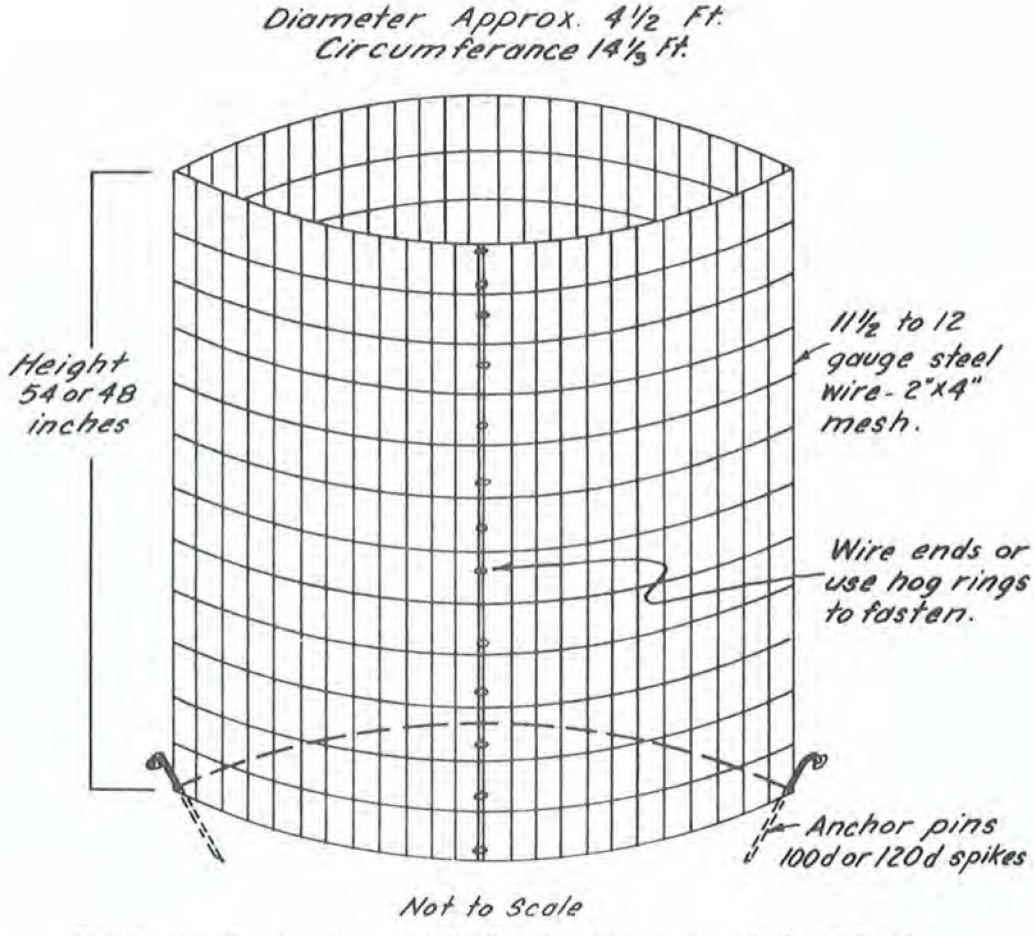
Mesh detail 2 rear sides same as front.
Use any good grade woven wire except poultry net 48" width.

This steel post and woven wire cage is used on the National Bison Range at Moiese, Montana. It is very durable. It is adapted to tall grass and sage types and can be used over low growing shrubs. It is preferred for Region 1 use.

This one can be made a smaller with 4½ FT Between Bottom of posts and (add rebar on Bottom. Makes The cage self standing and in Most cases does not Need to be staked.

PLAN 430-5

# CYLINDRICAL OPEN-TOP CAGE

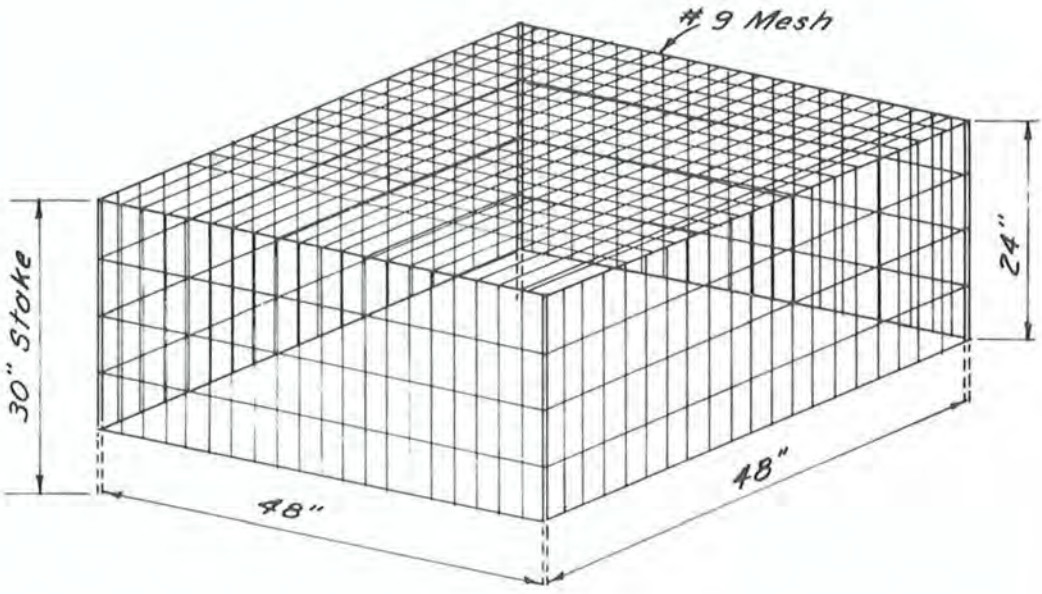

Diameter Approx. 4½ Ft.
Circumferance 14⅓ Ft.
Height 54 or 48 inches
11½ to 12 gauge steel wire - 2"x4" mesh.
Wire ends or use hog rings to fasten.
Anchor pins 100d or 120d spikes
Not to Scale

Made by Fastening 14⅓ feet of heavy duty steel wire into cylindrically shaped cage.

The cage is 48 or 50 inches high, built of Keystone nonclimable fence (extra heavy-duty wire, 2- by 4-inch mesh) or comparable. The fencing comes in 100-foot rolls at about $35 a roll. A roll makes seven cages when cut in lengths of 14-1/3-feet. This cage is just over 4.5 feet in diameter. It is big enough to permit clipping of a 9.6 square foot plot.

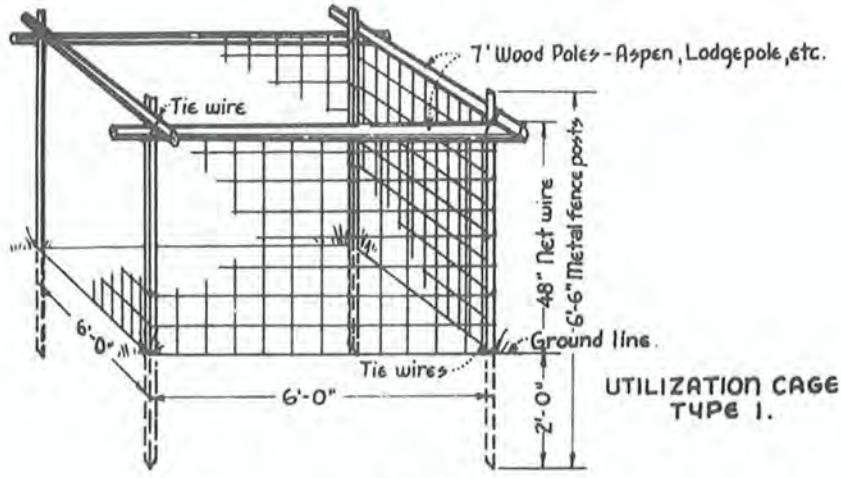
PLAN 430-6

# PREFABRICATED CUSTOM-BUILT AGRONOMY CAGE

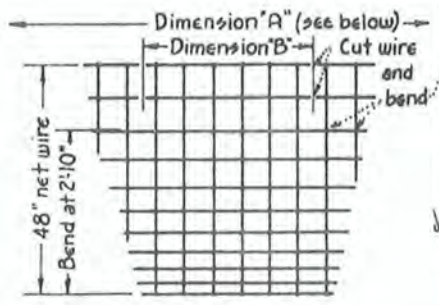



These come from the United Steel and Wire Company, Battle Creek, Michigan. Their 1956 catalog number was 1061-2. The 1956 prices were $9.89, $10.70, and $10.15 f.o.b. Missoula, Spokane, and Bozeman. Principal disadvantage is the 24-inch height in tall grass and sage areas. They may be knocked down into a flat package, size 4 feet by 4 feet.

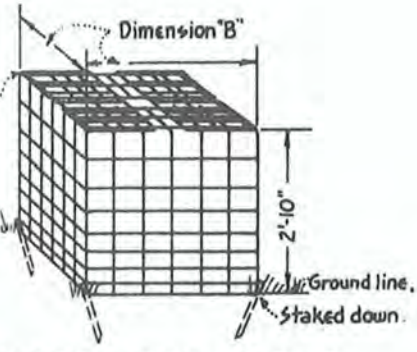
PLAN 430-7




UTILIZATION CAGE TYPE 1.



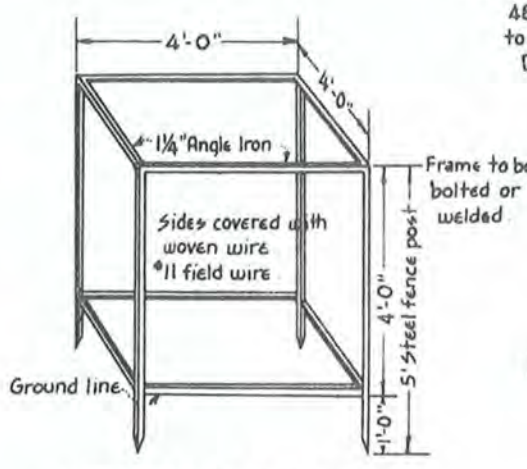

DETAIL OF CUTTING.




UTILIZATION CAGE - TYPE 2.

48" Netting wire may be cut to 3 lengths to make 3 nestling cages, for packing.
Dimension "A" · 12'-0" · 13'-0" · 14'-0"
" "B" · 3'-0" · 3'-3" · 3'-6"

Note: These cages may be constructed as four, angle-iron, wire covered panels, to be wired or bolted together in the field.

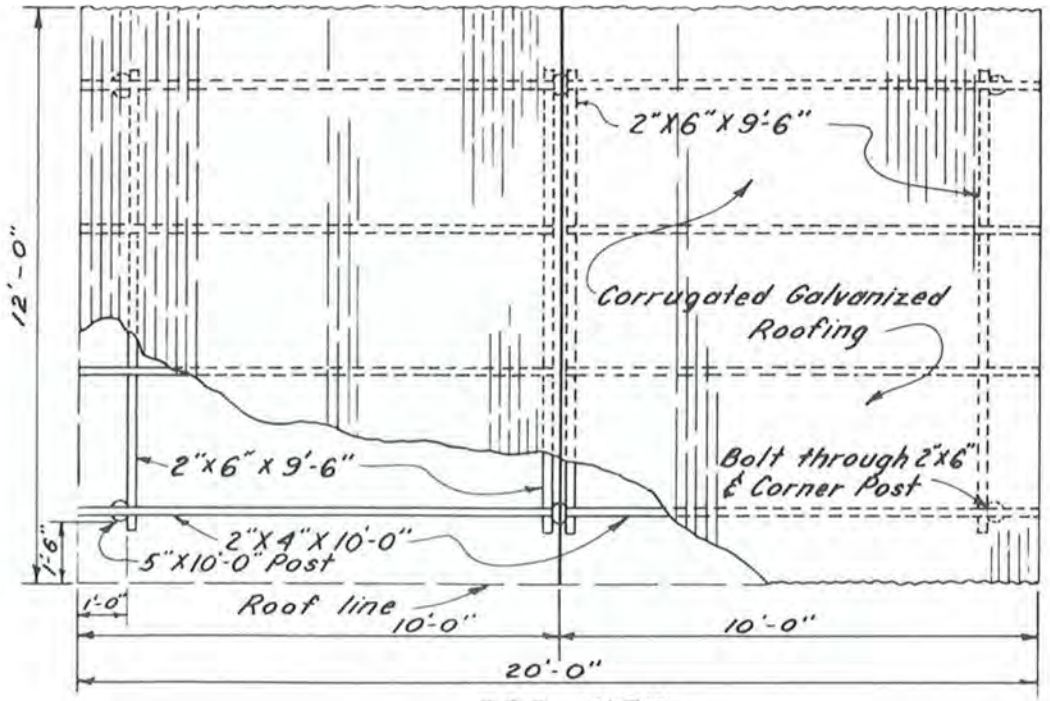



UTILIZATION CAGE-TYPE 3.
For heavy snow & easy moving.

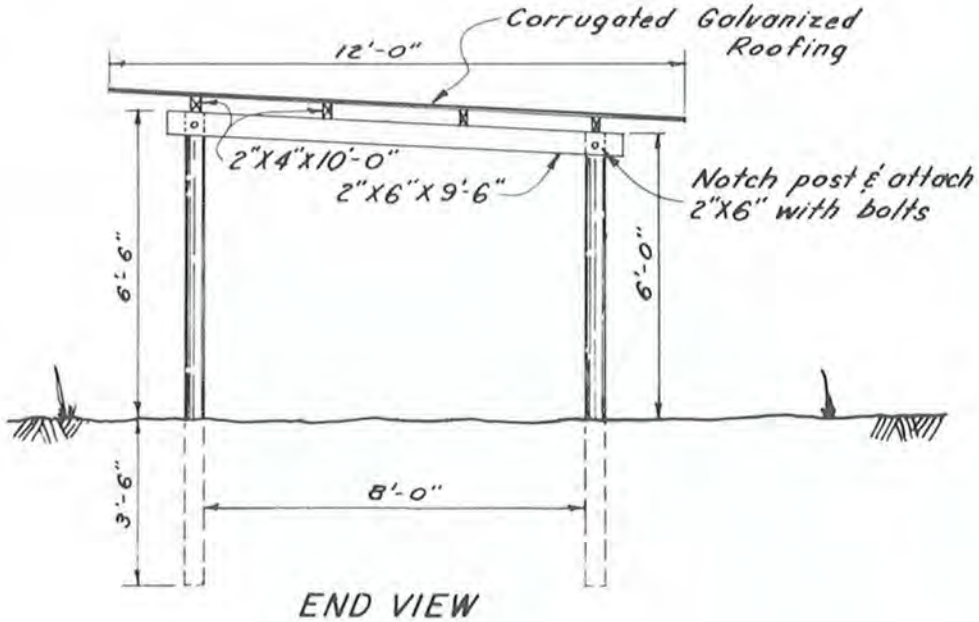
## UTILIZATION CAGES

PLAN 430-8

# PORTABLE CATTLE SHADE




TOP VIEW




END VIEW

PLAN 440-1